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MAGNETIC REMANANCE.

In an article elsewhere in this issue Messrs. Houston and Kennelly advance further proofs of the law recently announced by them concerning the relation between the magnetic remanance of soft iron and steel and the maximum cyclic intensity of induction. From the data of experiments by Prof. Ewing and Miss Klaassen, recently published in an English contemporary, it was found that, as in cases previously examined, a linear relation exists, actually or apparently, between the remanance and maximum cyclic intensity in iron and steel. Up to the present the results of all of the examinations made seem to show that the law holds true between the limits of about 9,000 and 500 gausses. In one instance, where the linear relation ceased at 9 kilogausses in a certain specimen of soft iron wire, it extended to 16 kilogausses after the same specimen was reannealed. It will be interesting to know if the linear relation holds good for hard steel, nickel and cobalt. Should it do so, the law will be proved general in its application and may have important consequences in a future theory of magnetism.

THE BERLINER CASE.

With reference to the appeal of the Berliner telephone case to the United States Supreme Court, it was recently stated, upon what was considered excellent authority, that counsel for the government would contend that the United States Circuit Court of Appeals had no jurisdiction in the matter, and that, therefore, its reversal of Judge Carpenter's decision was void of effect. We learn, however, that this statement was erroneous, and that, on the contrary, it is expected that a motion for dismissal will be made by the counsel for the Bell Company when the case comes before the Supreme Court, on the ground that the case is not appealable under the act creating the Circuit Court of Appeals. It is thought, however, in view of the fate of similar motions previously made, that this one will not prevail. The appeal will be taken early next week and it is expected that the case will come up for consideration soon after the commencement of the Fall term.

MATHEMATICS IN DESIGNING.

The article by Prof. Fessenden, in another column, on the use of magnetic formulæ in electrical design, brings out a number of interesting points relating to analytical methods for the determination of magnetic quantities, and shows that such methods in many cases may be of much practical value, though, we may add, some partisans of graphics may be loath to recognize this fact. It is largely with the latter that the gibes at "ironless mathematics" have originated and who, moreover, while condemning analytical methods for their complexity, frequently substitute graphical ones no less involved and lacking in inherent rationalism of the former. While, strictly speaking, the consideration of a circuit containing iron does introduce factors tending to complicate formulæ, yet within working limits these factors may frequently be neglected, the effect produced being of no practical importance. Prof. Fessenden shows why in the design of transformers the ordinary laws of harmonic curves may safely be applied, in this case reactions due to the presence of iron at other than extremely light loads not perceptibly affecting the form of the secondary curve of E. M. F. The formulæ deduced in the article promise to be of much use in the several ways pointed out. The construction of $\mathfrak{B}$-$\mathfrak{H}$ curves, for example, is thereby much simplified, it being merely necessary to determine two corresponding values of induction and M. M. F., and by their introduction in the formula given the other necessary points of the curve

may be obtained between practical limits. While in other applications of the equations referred to, some complexity results, the labor entailed by the use of the equations, to one accustomed to mathematical work, would seem to be well compensated for in the greater accuracy of the results thereby obtained and the saving of expense necessary to attain a similar end by, perhaps, costly experimentation. While the experimental method, even if not guided by mathematics, may be the best in the early development of an industry, when the main principles involved have thus been determined, their application thereafter can best be made by mathematical methods, which obviate recourse to experiments generally costly and often misleading unless elaborate in their nature. The knowledge of mathematics necessary to this end should be the equipment of every engineer, though we confess that but recently when mathematics had but little standing in designing, and the simplest innovation involved costly experiments, such knowledge would have perhaps resulted in disparagement of its possessor.

MULTIPLE-MOTOR TRACTION.

The article by Mr. Paul Hoho, in another column, is a thorough discussion of a question which promises to be one of importance when electric locomotives come more to the front. Mr. Hoho points out the complications which arise when two or more motors are used for traction purposes, and ascribes the low efficiency often observed to the slipping which results from the causes he describes. It would be interesting to know if any of the evil effects referred to have been encountered with the Baltimore and Heilmann locomotives for with these types it should be quite noticeable. The objections of Mr. Hoho to multiple independent motors were apparently anticipated by Mr. Frank J. Sprague, as the locomotive designed by the latter for the North American Company has the driving wheels so connected that the actions of the motors are not independent of each other. As will be seen, the author strongly advises the grouping of motors in parallel, and the taking of precautions with respect to the disposition of the load on the axles in order to avoid slipping. While with the usual motor car it is doubtful if practical circumstances will admit of any amelioration, the case is quite different with electric locomotives or high-powered cars. In the latter cases the method of control is less circumscribed by the necessity of frequent stoppages and changes of speed, and the coupling of the driving wheels is not impracticable.

CONSERVATISM AND OPTIMISM.

Prof. Stine, in another column, refers to the opposition met with in the introduction of steam railways, and to the skeptical manner in which claims were then met that now to us appear to be extremely modest. We hardly see, however, that any fair comparison can be made with respect to the introduction of steam and electric roads, for the tendency during the latter part of the century has been rather toward too great credulity and away from conservatism of belief. Formerly new discoveries were seldom regarded with a friendly feeling, and frequently they met with even violent opposition. This was probably due to the fact that only in recent years have educated men, in the proper sense of the word, occupied the higher positions in the engineering world. Formerly it was sufficient for a man to obtain his knowledge of a profession by experience alone, and a profession was then practiced more as a trade than a broad calling in which the consideration of principles is the prime requisite. Then an engineer's knowledge extended little beyond his daily tasks, and his system of training resulted in a limited adaptability. Innovations were viewed with prejudice, partly from habit, but principally because it was felt that their adoption would weaken a standing secure only when based on a knowledge acquired by long personal experience. Until those occupying professional positions came to be educated men in the modern sense of the word, progress was beset with difficulties, and even those who adopted new ideas did so most frequently as a matter of faith, and prejudiced their advancement by an advocacy which often consisted merely of personal abuse of the opposite side. The introduction of the principle of the expansive working of steam, for example, was accompanied by a violent warfare of personalities between the opposing sides, the scientific side of the question being rarely referred to, and the same was true to a less extent with respect to the introduction of the compound engine. Even at the present day a proposal brought before a meeting of steam railway master mechanics involving a change from present practice is likely to lead to a bitter personal controversy. On the other hand, at the present day any scheme, particularly if an electrical one, meets with the approbation of the public, and engineers, instead of opposing objections, are inclined to be rather too lenient in their public, if not private, expressions of approval, thereby often doing a real harm. It is to this optimistic manner of viewing everything electrical that the success of the vast army of electrical fakirs is due, representatives of which may be found in every town in the country and who in cities can be counted by scores. Their main argument consists in quoting bygone references to the impossibility of accomplishing what are now actualities, the tacit assumption being that the probability of falsity of such statement is as great to-day as formerly. This, as we have attempted to point out, is not true, the present tendency, on the contrary, being rather toward an undue optimism even on the part of the sober-minded. As to the question whether or not electricity will entirely replace steam on railways, it seems at present to be an idle one for the reason that such substitution, if it occurs, will be by progressive steps, and discussion of the matter will neither advance nor retard the end. There is no electrical problem connected with the substitution, it being probable that several manufacturers at the present time would be willing to supply, with guarantees, electric locomotives for any brand of the service now performed by their steam prototypes. Formerly the substitution of electric for steam traction might have been made a matter of faith and the subject of bitter controversy, but scientific enlightenment has changed all that. To-day it is merely a matter of dollars and cents, of engineering estimates and financial policy.

To Study American Railway Practice.

Monsieur Marechal, chief engineer of the city of Paris, arrived in this country last Saturday, and proposes to make a study of the subject of electrical propulsion for street railways in the United States. He is particularly interested in the underground system, and is now in Washington to investigate the construction and operation of the underground system recently completed by the Metropolitan line, and which is being successfully operated on Ninth Street, from the Potomac River to the Soldiers' Home, beyond the northern boundary of the city. Concerning the street railways of Paris, Mr. Marechal states that the authorities and people of that city are very much opposed to the overhead trolley system, and would not permit its introduction under any conditions. Three systems are operated in Paris by compressed air, but according to Mr. Marechal these do not work satisfactorily, owing to the large expense incidental to operation and difficulty in preventing the freezing of the compressors in Winter. After examining the underground system in Washington Mr. Marechal will go to New York and investigate the Lenox Avenue and other systems.

The Elihu Thomson Prize.

Dr. Arthur G. Webster, of Clark University, recently received notice from Paris that he had won the Elihu Thomson prize of 5,000 francs for the best treatise on electricity. The subject of Dr. Webster's thesis is "An Experimental Determination of Periods in Electrical Oscillations." The prize was originally instituted by the city of Paris for the best electric meter, and was awarded to Prof. Thomson. Desiring that it should serve to develop theoretical knowledge of electricity, Prof. Thomson requested that it be offered as a prize for the best work on a theoretical question. Dr. Webster, who has been thus honored is a Harvard graduate of the class of 1885.

Progress and Prejudice.

BY W. M. STINE.

The history of the introduction of past inventions and innovations contains many suggestions which are of signal application at the present time. To anticipate what may occur is, in the main, safer than to prophecy what will not take place. The current year bids fair to have much historical importance attached to itself. The Metropolitan Elevated, of Chicago; the Nantasket Beach Line, and other short railways upon which electricity is being introduced, have made this a leading question,—"Will electricity displace the steam locomotive?" Those who have attempted to reply, and others debating, would do well to consider the discussion which arose in the early part of the present century over the introduction of the steam railway. Two citations are appropriate and decidedly to the point:

"The opposition to railways at the commencement of their career is now a matter of history, and we can only look back with astonishment at the shortsightedness of our grandfathers; yet we must remember that the views of the general public were guided by persons who were supposed to be experts in engineering science, the majority of whom, in their narrow-minded ignorance and lack of enterprise, did all they could to stamp as folly the ideas of such men as George Stephenson and the other early promoters of railways and steam locomotion." And again, writing on this subject about this time (1829), the *Quarterly Review* said:

"As to those persons who speculate on making railways general throughout the kingdom, and superseding all the canals, all the wagons, mails, stage coaches, post chaises and, in short, every other mode of conveyance by land and water, we deem them and their visionary schemes unworthy of notice. The gross exaggeration of the locomotive steam engine (or, to speak in plain English, the steam carriage) may delude for a time, but must end in the mortification of those concerned. We should as soon expect the people to suffer themselves to be fired off upon one of Congreve's ricochet rockets, as to trust themselves to the mercy of such a machine going at such a rate."

These quotations are from "British Locomotions," by C. J. Bowen Cooke, pp. 17 and 21.

Storage Battery Cars for Madison Avenue.

After a lapse of six years the managers of the New York & Harlem Railway have determined to make another attempt within the next 90 days to run storage battery cars on their Fourth and Madison avenues line. Arrangements have been made for the equipment of the cars with accumulators for immediate service, and it is stated that a contract has been signed which provides, should the experiment prove a success, that the Second Avenue system will also use similar motive power.

Six years ago a number of storage battery cars were run on Fourth and Madison Avenues in this city, but owing to a patent litigation between rival companies the use of the cars was suddenly and unexpectedly enjoined.

The cars to be run on Madison Avenue will be of the standard type of electric car, 18-foot body and about 23 feet over all. The batteries will not be carried in the car body, as has hitherto been the practice, but will be suspended from the truck under the centre of the car. The tray or box containing the batteries is readily and quickly detachable from the truck and removed, for the purpose of charging, on a small transfer car running on rails to and from an elevator situated between the street car tracks and running beneath the floor to a cellar or subway.

The General Electric Company to Remain in Schenectady.

The question as to whether the General Electric Company would remain in Schenectady or remove to some other place was formally answered last week. The company will remain where it is. The commission appointed to appraise the property abutting on Kruesi Avenue, which street must be closed to give the company additional room required, finished its work on Thursday afternoon and gave fair values for the property, the whole parcel amounting to about $56,000. It is stated that the street will be closed almost immediately and that the General Electric Company will proceed to erect new buildings at a cost of $200,000. It is understood that at least 1,000 more hands will be employed by Oct. 1, making 5,000 in all. The Lynn works and the Harrison, N. J., works are to be transferred to Schenectady according to good authority, and ultimately 8,000 hands employed.

The Detroit Meeting of the Association of Edison Companies.

The 11th annual meeting or 16th convention of the Association of Edison Illuminating Companies was held in Detroit, on Tuesday, Wednesday and Thursday, August 13, 14 and 15, 1895.

The first session of the convention was called to order at 10 a. m., August 13, by Mr. C. L. Edgar, president.

After the roll call the executive committee, represented by its chairman, Mr. John I. Beggs, made a report recommending the acceptance of the application of three companies for admission, the Edison Light & Power Company, Pottsville, Pa.; the Toledo Electric Company, Toledo, O., and the Sault Ste. Marie Edison Company, Sault Ste. Marie. These were admitted.

A report by Mr. A. E. Kennelly (for Committee on Lighting Protection) was accepted and the committee discharged. Addresses were then made by Mr. S. D. Greene, of the General Electric Company, Mr. Insull, of Chicago, and Mr. Beggs, of Cincinnati, on the "Relations of the General Electric Company to Edison Licensee Companies," which excited considerable discussion, after which Mr. W. L. R. Emmet was called upon for his paper entitled "Some Comparison between the Direct-Current Low-Tension System and the Alternating Current and Multiphase System for Central Station Lighting." Mr. Emmet was unavoidably absent, and his paper was ordered printed in the minutes. The session then adjourned.

The second session was held at 2 p. m., and the Storage Battery Committee made report. In the discussion which followed Mr. Muller, of Hagen, Germany; Mr. C. L. Edgar, and Mr. J. W. Lieb, Jr., gave their experiences. A paper by Messrs. Pierce and Hale was then read by Mr. C. L. Edgar, of Boston, on "Energy Losses in the Boston Edison Station." After discussion on this paper the session adjourned.

The evening was devoted to a car ride and visit to "Lalla Rookh" (by courtesy of Detroit Edison Company).

The third session was called to order at 10 o'clock Wednesday morning. A paper by Mr. W. S. Barstow, on "Method of Charging for Current for Incandescent Lamps and Motors," provoked much discussion, and with Mr. Arthur Williams' paper, "Relation of Company to Customer," occupied the entire morning. The session adjourned at 1 p. m.

The afternoon session opened with a discussion by Mr. Beggs, Mr. Greene and Mr. Howell, on "Incandescent Lamps, Welsbach Light and Acetylene Gas." A paper by Mr. C. D. Haskins on "Facts in Relation to Mechanical Recording and Chemical Meters," was then read and discussion followed.

The evening was taken up by a drive and lunch on Belle Isle, given by the local Edison and the General Electric companies.

In accordance with past custom, the last day of the convention was given to entertainment, which took the form on this occasion of a delightful sail along the river at the invitation of the Detroit Edison Company, who, together with the General Electric Company, received the thanks of the convention for their many courtesies.

The sessions of this convention were particularly interesting on account of the lengthy and interesting discussions on the various papers.

Mr. Edison sent regrets for his inability to attend, as he was unable to leave his mining interests at Edison, N. J.

The General Electric Company presented each member of the association with a handsome badge representing the field magnet of a multipolar generator, from the centre of which hung a miniature incandescent lamp. The title of the association, the place of meeting and the date were neatly arranged around the field.

The next convention will be held at or in the vicinity of Brooklyn, commencing the second Tuesday in August, 1896, and continuing three days.

The following is the list of members present:

W. S. Andrews, Schenectady.
W. S. Barstow, Brooklyn, N. Y.
M. A. Beal, Cleveland.
John I. Beggs, Cincinnati.
Geo. W. Cato, Detroit.
B. M. Clark, Detroit.
J. S. Crider, Cumberland, Md.
C. L. Edgar, Boston.
H. T. Edgar, Atlanta, Ga.
A. W. Field, Columbus, Ohio.
C. P. Gilbert, Detroit.
S. D. Greene, Schenectady.

Caryl D. Haskins, Boston.
Samuel Insull, Chicago.
Winfield S. Jewell, Toledo, Ohio.
J. W. Leib, Jr., New York.
Robert Lindsay, Cleveland.
J. R. Lovejoy, Schenectady.
Daniel McCoy, Grand Rapids, Mich.
Adolph Muller, Hagen, Germany.
A. D. Page, Schenectady.
Geo. Peck, Detroit.
Hoyt Post, Detroit.
Charles R. Price, New Bedford, Mass.
Geo. A. Redman, Rochester, N. Y.
F. Sargent, Chicago.
Sam'l Scovil, Cleveland, Ohio.
Geo. R. Stetson, New Bedford, Mass.
Luther Stieringer, New York.
B. E. Sunny, Chicago
W. S. Thompson, Detroit, Mich.
A. F. Walker, Grand Rapids, Mich.
Edwin R. Weeks, Kansas City.
Ch. Westenfeld, Elgin City, Ill.
Geo. Wiley, Detroit.
Arthur Williams, New York.

AMONG THE VISITORS.

C. A. Coffin paid a flying visit to the convention.

G. A. Hurd looked after the affairs of the Crane Company, of Chicago.

B. F. Miles, vice-president of the National Carbon Company, of Cleveland, was about the lobby.

P. H. Alexander took a run down from Mt. Clement, where he is taking the water, to greet old friends.

S. A. Douglas, so long and favorably known in the electrical trade, arrived in town Wednesday afternoon.

Popular and energetic as ever, Mr. Insull, of the Chicago Edison Electric, was the central figure everywhere.

Mr. Albert Hoppin, one of the best known of the Western contingent, had a good deal to say for the E. P. Allis engine.

Martin J. Insull effectively represented Sargent & Lundy, of Chicago, and the Crocker-Wheeler Company, of New York.

Geo. McKinlock, president of the Central Electric Company, of Chicago, turned up Wednesday morning, serene and confident as usual.

Luther Stieringer was as much in evidence as ever, and was slated by the local papers as one of the most prominent characters present —and he was.

The Fisher rotary engine, seen in the basement of the Cadillac, attracted a great deal of attention and was the subject of much favorable comment.

W. S. Andrews, of the General Electric Company one of the pioneers of the early Edison days, found that he was still affectionately remembered by the "boys."

E. W. Little, vice-president and general manager of the Interior Conduit & Insulator Company, has achieved signal success with his company. He was very popular at the Detroit meeting.

Harry Edgar, of Atlanta, didn't report to the convention his receipt of a photograph of the brand-new Edgar. But he had it, just the same, and you could have told it in his face, at long range.

Messrs. C. P. Gilbert and Hoyt Post, who looked after the interests of the Detroit Edison Company and did the honors, left nothing to be desired. Both these gentlemen are old-time association characters, and none are better liked.

The well-known Hawley down-draft furnace, manufactured by the Hawley Down-Draft Furnace Company, of Chicago, was brought prominently to notice by the handsomely illustrated literature distributed by E. T. Hannan, Cincinnati agent.

G. A. Mansfield and W. D. Lockwood, of the Michigan Electric Company, received many congratulations on the deal just closed with the General Electric Company, by which the Michigan Company will look after the interests of the former in the peninsula.

The Warrens, senior and junior, who make up the Warren Electric Company, of Chicago, were in Detroit during the meeting looking after their new dynamo now being constructed by the Detroit Motor Company. This was highly spoken of by several prominent men.

Bailey Whipple had charge of the "Manhattan" arc lamp burning in the parlor and gave away a little pamphlet headed "Put in a New Carbon and Trim Your Lamp Once Every Hundred and Fifty Hours—That's Profit." This brief sentence told a volume. Mr. Whipple was an eloquent advocate.

S. Dana Greene, one of the best diplomats in the General Electric service, handled the interests of that company with his usual ability. He was eminently successful in brushing away all the obstacles that stood between the General Electric Company and its licensees, and when the meeting was over there was a universal air of peace and perfect harmony.

Accumulator Traction in Paris.

In view of the reviving interest in accumulator traction which is now being manifested in this country, the apparent success which has been obtained with accumulators by the Paris Tramway Company naturally attracts attention and excites the hope that this system may be brought to a practical basis in America.

It cannot be denied, of course, that there are definite and positive limitations to the use of accumulators for traction purposes, but the Paris line is by no means an easy one to traverse, and for this reason the success of the accumulator there is all the more marked and encouraging.

The most interesting feature of the system is the accumulator, which is the Laurent-Cely, a species of the well-known chloride cell. The charging of the accumulators is at present effected with two constant differences of potential of 250 and 280 volts. Formerly, the charging was done at a constant E. M. F. of 265 volts. The result was, that at the beginning of the charge the volume of current was very high, but continually diminished until it reached a very low value, which prolonged the duration of the charge. Now the charge begins at about 250 volts, with which E. M. F. the current ranges from 70 to 80 amperes; when it falls to 10 or 15 amperes, boosters are coupled in series with the machines. The voltage then goes up to 280, and the current to 70 amperes; this intensity then gradually falls. The coupling of the booster is effected from the switchboard by means of an automatic switch.

The first negative plates of the accumulators, in which the active material was obtained by the reduction of the chloride of lead, have resisted perfectly all operations connected with the railway; their duration has exceeded 93,000 car miles, and their wear has been very slow. But the positive plates, on the other hand, have deteriorated very rapidly; after one series of charges and discharges the peroxide of lead has fallen. To avoid these drawbacks a type of plates was adopted having a central core with channels, constituting a series of little receivers to hold the active material in place. These new positive plates have the great advantage of being recoated after being in use a certain time; all the peroxide that has fallen to the bottom of the troughs is collected and replaced in the channels. The material falls somewhat rapidly, but the support remains intact. The new plates have enabled the intensity of the discharge to be increased, and the battery now used on the cars contains only 56 elements of nine plates, each plate about eight inches square, the total weight being 3,740 pounds.

The car employed is supported on a truck placed in the centre, leaving an "overhang" at each end, similar to the American cars. The truck and the framework are rigid, and the wheel base is 6 feet. The total weight of the car is 11.7 tons when ready for service. The battery of accumulators is completely enclosed in a case which is placed underneath the car between the axles.

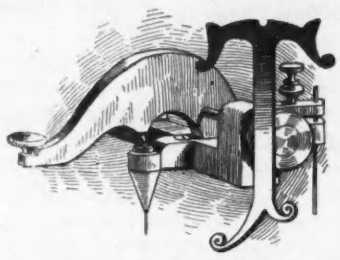
There are two bipolar motors to a car, each of 10 kw, connected to the axles through single-reduction gearing. The motors are shunt-wound and are geared to run at about 500 revolutions per minute. The controller consists of a switch which varies the connections between the field magnet, the armatures and resistances. A very powerful electric brake action can be used if required, consisting of an arrangement for short-circuiting the armature. Experiments have shown that this brake rendered the employment of ordinary brakes quite unnecessary; nevertheless, in order to fulfill official requirements, a regular hand brake has had to be added.

The shunt motors with which each car is provided enables it to recuperate electrical energy going down grades. This recuperation, which sometimes amounts to 18 per cent., has the great advantage of supplying the accumulators from time to time with a small charge, just after they have furnished their highest discharge.

The system has been subjected to some very severe tests, and the results obtained are reported as being exceedingly satisfactory. The lines on which the system is employed are by no means level, and the many stops which are made furnish excellent opportunities for testing the endurance of storage batteries under frequent heavy discharges.

The Invention of the Electromagnetic Telegraph.—III.

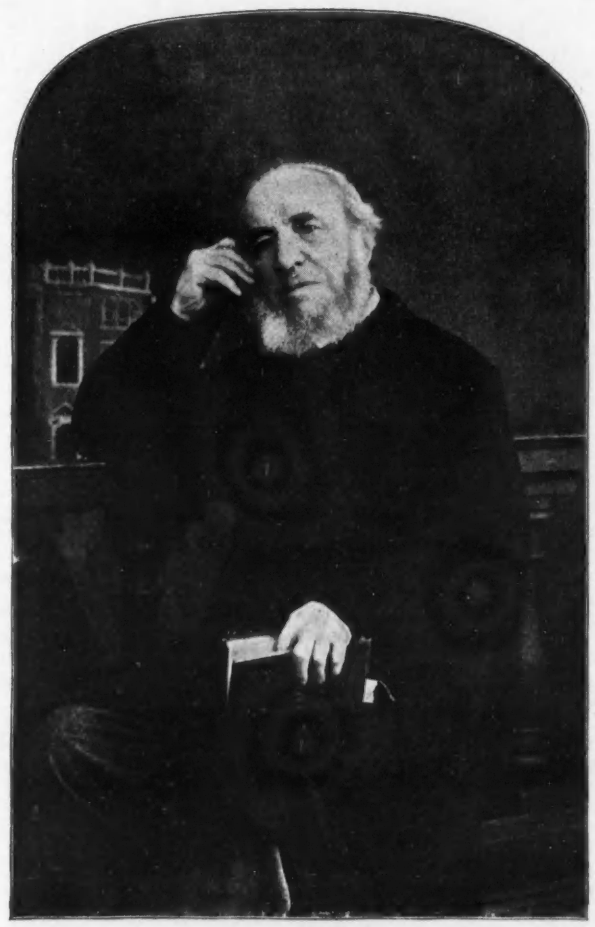
BY J. J. FAHIE.



THE editors of THE ELECTRICAL WORLD have invited me to contribute an article on the Morse-Henry-Vail controversy, which might be considered as presenting the English views of the case. While cheerfully acceding to this request, I wish it to be understood that, in what follows, I speak for myself alone, for I am afraid it will be found that the English views are as little unanimous as the American.

In the years 1830-37 Europe* was busy with experiments on electromagnetic telegraphs. Referring your readers to my "History of Electric Telegraphy" for details, it will be enough to mention here the labors of Ampère, 1820; Ritchie and Booth, 1830; Schilling, 1825-37; Gauss and Weber, 1833-37; Steinheil, Davy, and Cooke and Wheatstone, 1836-37; Alexander, 1837; and many others. Notices of some of these experiments, it must be supposed found their way occasionally into American newspapers.

At all events, telegraphs of some sort were in the air in the United States early in 1837; for, on Feb. 3 in that year, we find the House of Representatives passing a resolution requesting the secretary of the treasury to report to the House at its next session, upon the propriety of establishing a system of telegraphs for the United States. In compliance with this resolution, a circular was issued, on March 10, by the Hon. Levi Woodbury, addressed to the collectors of customs and other scientific men in different parts of the country, calling for information on the subject, and desiring a reply by Oct. 1. The circular speaks of communication "by cannon or otherwise; or, in the night, by rockets, fires, etc.," and makes no special reference to electric telegraphs.



EDWARD DAVY.

On April 15, and apparently with reference to the above circular, Sidney Morse, Prof. Morse's brother, and, according to Dr. Hamel, the editor of a New York paper, published an article in the New York *Observer* in which he vaguely mentions an electric telegraph requiring 26 wires. In the appendix to Morse's "Modern Telegraphy" (Paris, 1867, p. 15), Leonard Gale, Morse's friend and fellow professor in the University of the City of New York, tells us that Prof. Morse gave his consent to this public reference to his telegraphic projects, being moved thereto by announcements of Gonon and Servill's telegraph, which, however, proved to be of the common semaphore type. Sidney Morse, on the other hand, states, on page 8 of the same appendix, that the telegraph mentioned by him was his own idea and not that of his brother, which he was well acquainted with, and which required only one wire. As a possible explanation of this discrepancy we give the following passage from Vail's "Electromagnetic Telegraph," page 30:

"During the period of 13 years [1832–45] many plans have been devised by the inventor [Morse] to bring the telegraphic alphabet to its simplest form. The plan of using the common letters of the alphabet, 26 in number, with 26 wires, one wire to each letter, has received its due share of his time and thought. Other modes of using the common letters of the alphabet, with a single wire, have also been under his consideration. Plans of using two, three, four, five and six wires to one registering machine have, in their turn, received proportionate study and deliberation. But these and many other plans, after much care and many experiments, have been discarded, he being satisfied that they do not possess that essential element, simplicity, which belongs to his original first thought, and the one which he has adopted."

For some months we find no public reference to Morse's projects. Meanwhile accounts of electric telegraphs were multiplying in the European (especially English) papers, and these notices were certainly known to Morse, as we shall presently see. At the end of August, 1837, according to Hamel, the *Neue Wurzburger Zeitung*, of June 30, was received in America, containing an account of Steinheil's experiments at Munich. This was translated into a New York paper on Sept. 1, and on the following day a paragraph appeared, inspired, it is thought, by Morse, and stating that "the editors of newspapers in America, who copy such articles from European papers, do not seem to be aware that the electric telegraph, which now as the wonder of the age seems to have excited in Europe the attention of the scientific public, was an American discovery, and that Prof. Morse had conceived it five years ago on his return voyage from France." As it was added that Morse had his telegraph then near his lodgings, there came on the same day several curious persons to see it, among them Dr. Daubeny, of the Oxford University; Prof. Gale, above mentioned, and Mr. Alfred Vail. The experiments were not encouraging, but two days later Morse succeeded better in getting his machine to print a few words (Hamel's "Historical Account," etc., Cooke's reprint, 1859, p. 65). These results were communicated to the New York *Journal of Commerce*, and were published in its issue of September 7 1837.†

Referring to his conception of the idea of the electromagnetic telegraph, Morse testified before the United States Supreme Court as follows: "Shortly after the commencement of my return voyage from Europe in the Autumn of 1832, the then recent experiments and discoveries in relation to electromagnetism, and the affinity of electricity to magnetism, or their probable identity, became the subject of conversation. A special topic was the obtaining the electric spark from the magnet. In the course of the discussion it occurred to me that, by means of electricity, signs representing figures, letters or words might be *legibly written down* at a distance. The idea thus conceived took full possession of my mind, and during the residue of the voyage I occupied myself by devising means of giving it practical effect. Before I landed in the United States I had drawn out in my sketch book the form of an instrument for an electromagnetic telegraph, and had noted down a system of signs, composed of dots and spaces, which were to represent numerals, and these were to indicate words to which they were to be prefixed in a telegraphic dictionary where each word was to have its own number. I also drew out a mode of applying the electric or galvanic current so as to make these signs by its chemical effects in the decomposition of salts, and also to make sounds for telegraphing. Immediately after my landing I communicated my invention to a number of my friends, and employed myself in preparations to prove its practicability and value by actual experiments. To that end before the commencement of the year 1833, being at the house of my brother in New York, I made a mould and cast a set of type representing dots and spaces for closing and breaking the circuit in my contemplated experiments."‡

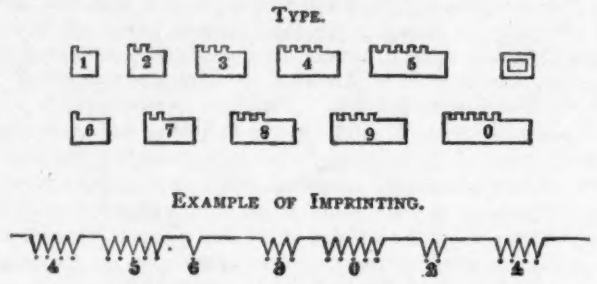
Nothing further appears to have been done in the way of construction for some years, as we learn from Morse's letter to the secretary of the treasury, dated Sept. 27, 1837, where he said he cast a species of type the first week after his arrival home [Novem-

*Later on we will deal fully with Henry's experiments in America.

† See Mr. F. W. Jones's article, pp. 71 and 72, *ante*. Shaffner, "Telegraph Manual," p. 400, gives a diagram of the printing, but with November, 1835, instead of September, 1837. Curiously, the same group of figures, 112, does duty for November and September, words which must have been widely apart in the dictionary

‡ *Vide* Fig. 7, Mr. Jones's article, p. 107, *ante*.

ber, 1832], and, although the rest of the machinery was planned yet from the pressure of unavoidable duties, he was compelled to postpone his experiments, and was not able to test the whole plan until



SPECIMENS OF TYPE AND PRINTING.

within a few weeks. In a letter to Dr. Jackson, dated Sept. 18, 1837, refuting the doctor's claim to a share in the invention, Morse says:

"The discovery, so far as we alone are concerned, belongs to me. If by an experiment which we proposed to try together, we had mutually fixed upon a successful mode of conveying intelligence, we might with some propriety be termed joint inventors, but as we have never tried any experiment together, nor has the one proposed to be tried by you [on the chemical effects of the electric current] been adopted by me, I cannot see how we can be called joint inventors. You are aware, perhaps, that the mode I have carried into effec- after many and various experiments, with the assistance of my colleague, Prof. Gale, was never mentioned either by you or to you."

In another letter to the same person, dated Dec. 7, 1837, Morse says:

"I readily allow your excuses for not trying the experiments [on the chemical effects of the electric current], but these excuses do not alter the fact that your neglect retarded my invention, and compelled me, after five years' delay, to consider the result of that experiment as a failure, and consequently to devise another mode of applying my apparatus—a mode entirely original with me."

The discrepancy in these extracts should be noted. In the first Morse says the machinery, as it existed in 1837, was "planned" in 1832, whereas in the third he distinctly states it was "devised" only after five years' delay. The evidence of the captain of the ship *Sully* as quoted in Shaffner's "Telegraph Manual," p. 410, would seem to bear out Morse's first statement, but this is so evidently a case of being wise after the event, that I am inclined to set little value on the gallant officer's deposition. The probability is that Morse's vague ideas of 1832 did not begin to take shape until about 1836. Indeed, Morse himself admits as much in the "American Telegraph Magazine," of Dec. 15, 1852, p. 130, where he says: "The truth is, the child was born and breathed, and spoke in 1835."

Morse thus describes the construction of his first machine:

"In 1835 I was appointed a professor (of the Literature of the Arts of Design) in the New York City University, and, about the month of November of that year, I occupied rooms in the University buildings. There I immediately commenced, with very limited means, to experiment on my invention. My first instrument was made up of an old picture or canvas frame, fastened to a table; the wheels of an old wooden clock, moved by a weight, to carry the paper forward; three wooden drums, upon one of which the paper was wound, and passed over the other two; a wooden pendulum, suspended from the top piece of the frame and vibrating across the paper as it passed over the central drum; a pencil at the lower end of the pendulum in contact with the paper; an electromagnet fastened to a shelf midway across the frame and opposite to an armature made fast to the pendulum; a type rule and type for closing and breaking the circuit, and resting on an endless band (composed of carpet binding) which passed over two wooden rollers moved by a wooden crank and carried forward by points projecting from the bottom of the rule downward into the carpet binding; a lever with a small weight on the upper side and a tooth projecting downward at one end operated on by the type; a metallic fork also projecting downward over two mercury cups; and a short circuit of wire, embracing the helices of the electromagnet, connected with the positive and negative poles of the battery and terminating in the mercury cups."*

In another place Morse says:

"In 1836 and the early part of 1837 I directed my experiments mainly to modifications of the marking apparatus, contrivances for using fountain pens; marking with a hard point through pentagraphic or blackened paper; varying the modes of using and moving the paper at one time on a revolving disc spirally from the centre, at another on a cylinder, by which means a large ordinary sheet of paper might be so written upon that it could be read as a common place book and bound for reference in volumes; and devising modes of marking upon chemically prepared paper." (Shaffner, p. 412.)

All these experiments would seem to have taken place at a much later date than Morse assigns to them, probably at various times between 1838 and 1848.

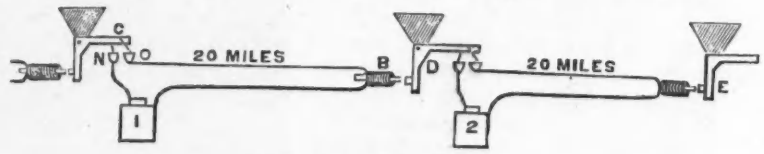
Early in 1836, on experimenting through 40 feet of copper wire. Morse found that his battery of one cup was not sufficient to work the register. This result, he says, "suggested to me the probability that the magnetism to be obtained from the electric current would diminish in proportion as the circuit was lengthened so as to be insufficient for any practical purpose at great distances, and to remove that probable obstacle, I conceived the idea of combining two or more circuits together, each with an independent battery, making use of the magnetism of the current on the first to close and break the record, the second, the third, and so on." The accompanying illustration shows this plan, showing two 20-mile circuits. Shaffner (p. 411) says: "This plan could telegraph only in one direction. To communicate back, another combination of circuits would have to be arranged upon the reverse order. At that time there was no evidence on record demonstrating that a circuit as great as 20 miles could be operated. The apparatus, therefore, was based upon theory." The plan thus "conceived" early in 1836 was, apparently, not "matured" until the Spring of 1837,† when Morse says he showed it to Prof. Gale, his confidential friend.

The following is Prof. Gale's account of what he saw on this occasion:

"In the Winter of 1836-37 Mr. Morse, who as well as myself was a professor in the University of the City of New York, came to my lecture room and said he had a machine in his lecture room or studio which he wished to show me. I accompanied him to his room and there saw, resting on a table, a single-pair galvanic battery, an electromagnet, an arrangement of pencil, a paper covered roller, pinion wheels, levers, etc. At this time, as Morse assured me, no man had seen the machine except his brother, Sidney E. Morse." (Taylor, p. 41.)

In a letter to Prof. Henry, Gale further adds:

"The battery was the cylinder form of battery with a single pair of plates, and the electromagnet was that known as Moll's, and shown in drawings of the older works on that subject, having only a few turns of wire in the coil which surrounded the poles or arms of the magnet. The sparseness of the wires in the mag-



THE FIRST RELAY.

net coils and the use of the single-cup battery were to me, on the first look at the instrument, obvious marks of defect, and I accordingly suggested to the Professor, without giving my reasons for so doing, that a battery of many pairs should be substituted for that of a single pair, and that the coil on each arm of the magnet should be increased to many hundred turns each; which experiment, if I remember aright, was made on the same day with a battery and wire on hand, furnished, I believe, by myself, and it was found that while the original arrangement would only send the electric current through a few feet of wire, say 15 to 40, the modified arrangement would send it through as many hundred. Although I gave no reason at the time to Prof. Morse for the suggestions I had proposed in modifying the arrangement of the machine, I did so afterward, and referred in my explanations to the paper of Prof. Henry, in the 19th volume of the "American Journal of Science," 1831, p. 400 and onward. . . .

At the time I gave the suggestions above named, Prof. Morse was not familiar with the then existing state of the science of electromagnetism. Had he been so, or had he read and appreciated the paper of Henry, the suggestions made by me would naturally have occurred to his mind as they did to my own. But the principal part of Morse's great invention lay in the mechanical adaptation of a power to produce motion, and to increase or relax at will. It was only necessary for him to know that such a power existed for him to adapt mechanism to direct and control it.

"My suggestions were made to Prof. Morse from inferences drawn by reading Prof. Henry's paper above alluded to. Prof. Morse professed great surprise at the contents of the paper when I showed it to him, but especially at the remarks on Dr. Barlow's results respecting telegraphing, which were new to him, and he stated at the time that he was not aware that any one had even conceived the idea of using the magnet for such purposes." ("Smithsonian Report," 1857, p. 93.)

* For a plan of this instrument, as well as for the types and the various early methods employed for mounting and moving them, see Shaffner's "Telegraph Manual," pp. 404-430.

† If even then. Gale says the system of working by relay, although not in the machine when I first saw it, was discussed in an early part of 1837. See "Smithsonian Report," 1878, Taylor's reprint, p. 65; also p. 99, where good reasons are given for assigning its construction to a date posterior to the report of the Franklin Institute, on Feb. 8, 1838.

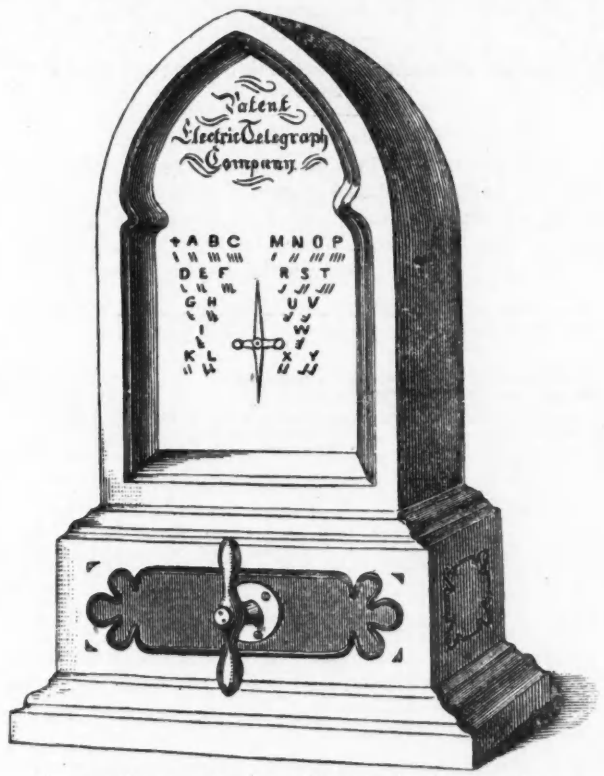
With reference to the semi-public experiments half a year later, mentioned above in paragraphs 5 and 6, Prof. Gale says:

"On Saturday, the 2d of September, 1837, Dr. Daubeny and others were invited to see the operations of the telegraph in its then rude form, in the cabinet of the New York City University, where it then had been put up with a circuit of 1,700 feet of copper wire, stretched back and forth in the room. This exhibition of the telegraph, although of very rude and imperfectly constructed machinery, demonstrated to all present the practicability of the invention, and resulted in enlisting the means, the skill and the zeal of Mr. Alfred Vail." (Taylor, p. 43.)

To an account of these experiments, published in the October number of *Silliman's Journal*, it was added:

"Since the 4th of September 1,000 feet more of wire, No. 23, have been added, making in all 2,700 feet, or more than half a mile of a reduced size of wire [the original size being No. 16.] The register still recorded accurately. Arrangements have been made [with Messrs. Vail] for contructing new and accurate machinery. Prof. Gale is engaged with Prof. Morse in making some interesting experiments connected with the invention, and to test the effect of length of wire on the magnet izing influence of voltaic electricity." (Taylor, p. 44.)

Here we must interrupt for a moment the thread of our narrative,

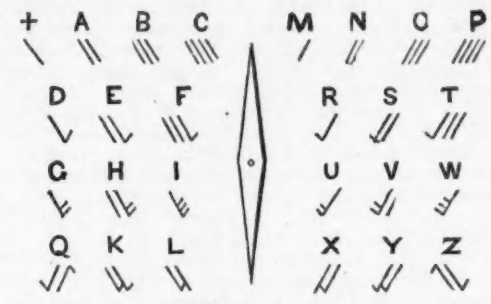


SINGLE-NEEDLE ENGLISH TELEGRAPH INSTRUMENT.

in order to briefly allude to Prof. Henry's independent experiments We shall see that, had he given his mind to it, he could easily have constructed a practicable telegraph of the electromagnetic form before 1832, of all the essentials for which he had a clearer knowledge than any one at that period. In 1828 Henry began his brilliant series of researches in electromagnetism, a *résumé* of which will be found in my "History of Electric Telegraphy," pp. 286-296.

"Previous to these investigations," says Henry,* "the means of developing magnetism in soft iron were imperfectly understood. The electromagnet made by Sturgeon, and copied by Dana, of New York, was an imperfect quantity magnet, the feeble power of which was developed by a single battery. It was entirely inapplicable to a long circuit with an intensity battery, and no person, possessing the requisite scientific knowledge, would have attempted to use it in that connection after reading my paper. In sending a message to a distance two circuits are employed, the first, a long circuit through which the electricity is sent to the distant station to bring into action; the second a short one, in which are the local battery and magnet for working the machine. In order to give projectile force sufficient to send the power to a distance it is necessary to use an intensity battery in the long circuit; and in connection with this, at the distant station, a magnet surrounded with many turns of one long wire must be employed to receive and multiply the effect of the current, enfeebled by its transmissions through the long conductor. Accordingly the receiving magnet consists of a horseshoe magnet surrounded with many hundred turns of a single long wire, and is operated with a battery of from 12 to 24 elements, or more; while on the local circuit it is customary to employ a battery of one or two elements and an electromagnet with a much thicker wire and fewer turns.

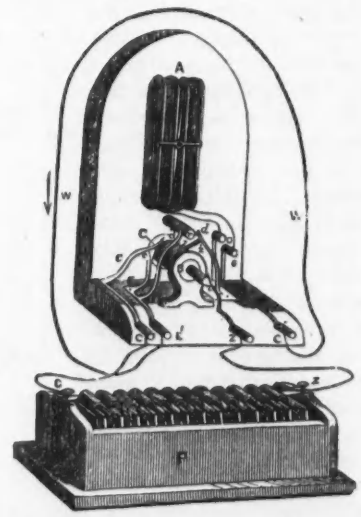
"It will, I think, be evident that these were improvements in the electromagnet which first rendered it adequate to the transmission of mechanical power to a distance, and had I omitted all allusion



SINGLE-NEEDLE ALPHABET.

to the telegraph in my paper the conscientious historian of science would have awarded me some credit, however small might have been the advance which I made. I briefly, however, called attention to the fact of the applicability of my experiments to the construction of the telegraph, but not being then familiar with the history of the attempts made in regard to this invention, I called it 'Barlow's project,' whereas I ought to have said that Barlow's investigations merely tended to disprove the possibility of a telegraph.† I did not refer exclusively to the needle telegraph when, in my paper, I stated that the magnetic action of a current is at least not sensibly diminished by passing through a long wire (in the circuit of an intensity magnet). This is evident from the fact that the immediate experiment from which this deduction was made was by means of an electromagnet and not by means of a needle galvanometer. At the conclusion of the series of experiments which I described in *Silliman's Journal* there were two applications of the electromagnet in my mind—one, the production of a machine to be moved by electromagnetism, and the other the transmission of, or calling into action, power at a distance. The first was carried into execution in the construction of the machine described in *Silliman's Journal*, Vol. 20, 1831; and for the purpose of experimenting in regard to the second, I arranged round one of the upper rooms in the Albany Academy a wire of more than a mile in length, through which I was enabled to make signals by sounding a bell. The mechanical arrangement for effecting this object was simply a steel bar, permanently magnetized, of about 10 inches in length, supported on a pivot, and placed with its north end between the two arms of a horseshoe electromagnet. When the latter was excited by the current the end of the arm thus placed was attracted by one arm of the horseshoe and repelled by the other, and was thus caused to move in a horizontal plane, and its further extremity to strike a bell suitably placed. This arrangement is that which is alluded to in Prof. Hall's letter‡ as having been exhibited to him in 1832. It was not however, at that time connected with the long wire above mentioned, but with a shorter one put up around the room for exhibition.

"In February, 1837, I went to Europe, and early in April (the 11th) of that year, Prof. Wheatstone, in the course of a visit to him at King's College, London, with Prof. Bache, now of the United States Coast Survey, explained to us his plans of an electromagnetic telegraph; and, among other things, exhibited to us his method



INTERIOR AND CONNECTIONS OF SINGLE-NEEDLE INSTRUMENT.

of bringing into action a second galvanic circuit. This consisted in closing the second circuit by the deflection of a needle, so

* Our extracts are from the "Smithsonian Report," 1857.

† For Barlow's experiment see the writer's "History of Electric Telegraphy," p. 306.

‡ See p. 96 of the "Smithsonian Report" for 1857. See also Taylor's reprint, p. 77, for other corroborative evidence.

placed that the two ends of the open circuit projecting upward would be united by the contact of the end of the needle when deflected, and of opening or breaking the circuit so closed by opening the first circuit and thus interrupting the current, when the needle would resume its ordinary position under the influence of the magnetism of the earth. I informed him that I had devised another method of producing effects somewhat similar. This consisted in opening the circuit of my large quantity magnet at Princeton, when loaded with many hundred pounds weight, by attracting upward a small piece of movable wire, with a small intensity magnet, connected with a long-wire circuit. When the circuit of the large battery was thus broken by an action from a distance, the weights would fall, and great mechanical effect could thus be produced, such as the ringing of church bells at a distance of a hundred miles or more, an illustration which I had previously given to my class at Princeton. My impression is strong, that I had explained the precise process to my class before I went to Europe. I am, however, certain of having mentioned in my lectures every year previously, at Princeton, the project of ringing bells at a distance, by the use of the electromagnet, and of having frequently illustrated the principle of transmitting power to a distance to my class, by causing in some cases a thousand pounds to fall on the floor, by merely lifting a piece of wire from two cups of mercury closing the circuit.

"The object of Prof. Wheatstone, as I understood it, in bringing into action a second circuit, was to provide a remedy for the diminution of force in a long circuit. My object, in the process described by me, was to bring into operation a large quantity magnet, connected with a quantity battery in a local circuit, by means of a small intensity magnet, and an intensity battery at a distance.

"The only other scientific facts of importance to the practical operation of the telegraph, not already mentioned, are the construction of the Constant Battery, in 1836, by Prof. Daniel, of King's College, London, and the discovery, in 1837,* by Steinheil, of using the earth as a portion of the galvanic circuit. I believe that I was the first † to repeat the experiment of Daniell and Steinheil in America. I stretched a wire from my study to my laboratory, through a distance in the air of several hundred yards, and used the earth as a return conductor, with a very minute battery, the negative element of which was a common pin, such as is used in dress, and the positive element the point of a zinc wire immersed in a single drop of acid. With this arrangement a needle was deflected in my laboratory before my class."

In the Autumn of 1837 Prof. Henry was on a visit to New York, and there accidentally made the acquaintance of Prof. Morse. "He appeared," says Henry, "to be an unassuming and prepossessing gentleman, with very little knowledge of the general principles of electricity, magnetism, or electromagnetism. He made no claims, in conversation with me, to any scientific discoveries, or to anything beyond his particular machine and process of applying known principles to telegraphic purposes. He explained his plan of a telegraph, which I thought better than any with which I had been made acquainted in Europe. I became interested in him, and (subsequently) gave him a certificate, in the form of a letter,‡ stating my confidence in the practicability of the electromagnetic telegraph, and my belief that the form proposed by himself was the best that had been published." Prof. Morse subsequently visited Henry several times between 1839 and 1845, to confer with him on the principles of electricity and magnetism. At these times, as well as on other occasions by letter, every information was freely accorded. The interview which took place early in May, 1839, and which occupied a whole afternoon and evening, must have been very satisfactory to Morse, for, among other points on which his doubts were settled, he took away the comforting assurance that Henry foresaw no difficulty in magnetizing soft iron through a wire at a distance of a hundred miles or more. (Taylor, pp. 51, 93.)

We conclude this digression with the following appreciative reference to Henry's labors in the (London) *Electrical Review*, Aug. 12, 1887:

"It was only by Henry's discoveries that the electromagnetic telegraph of Morse became possible, and Morse himself, before he became involved in patent litigation, freely acknowledged his indebtedness to Henry. But Prof. Henry, long before Morse's telegraph came before the world, had suggested the application of his electromagnets to telegraphy, and had even constructed a form of bell telegraph for experimental purposes which answered remarkably well. Henry, however, had for his object 'the advancement of science, without any special or immediate reference to its application to the wants of life or useful purposes in the arts.' He sought no patents for inventions, and solicited no remuneration for his labors, other than credit for having done what it was in him to do for the promotion of scientific knowledge. He gave freely to the world the results of his researches, and others devoted themselves to the practical applications of the principles which he discovered. Of these were not only Morse, in America, but Wheatstone and Cooke, in this country. It has been amply demonstrated that these inventions were at a standstill in the early part of 1837 for the want of a means of producing a strong effect at the receiving station. Although Henry had clearly shown the advantage of employing closely-wound coils of fine wire in 1831, Wheatstone knew nothing apparently of this, and remained in ignorance until April, 1837, when he was enlightened by Prof. Henry himself. We are firmly convinced that Henry did more for the advancement of the telegraph than has ever yet been adequately acknowledged."

(To be continued.)

* Correctly, July, 1838, Steinheil made this most important discovery *accidentally*, but seven months earlier, Dec. 8, 1837, it was distinctly suggested by an Englishman. See my "History of Electric Telegraphy," p. 345.

† As was Davy in England. See my "History of Electric Telegraphy," p. 354.

‡ This letter, dated Feb. 24, 1842, materially assisted Morse in securing his grant of $30,000 from Congress. See Taylor, p. 92, for some interesting letters which passed between Henry and Morse.

On an Approximate Law of Magnetic Remanance in Iron and Steel.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

Since the publication, in The Electrical World of June 1, 1895, Vol. XXV., of our note, entitled "On a Possible Law of Residual Magnetism in Iron and Steel," Prof. Reginald A. Fessenden has published in The Electrical World for Aug. 3, 1895, Vol. XXVI., No. 5, p. 133, an interesting contribution to this subject, in which he shows that a sample of soft iron tested by him gave a practically linear relation between remanance and maximum cyclic intensity as far as 10 kilogausses of maximum intensity, but that beyond this limit the relation failed.

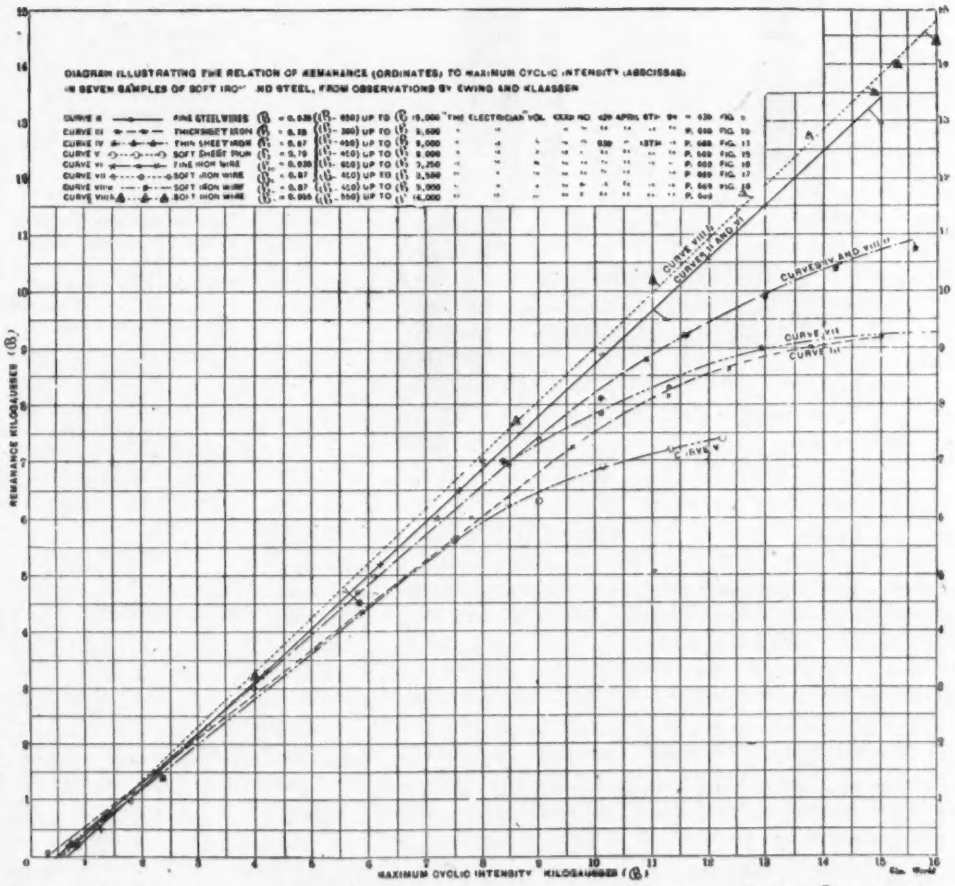


DIAGRAM ILLUSTRATING THE RELATION OF REMANANCE (ORDINATES) TO MAXIMUM CYCLIC INTENSITY (ABSCISSAE)
IN SEVEN SAMPLES OF SOFT IRON AND STEEL, FROM OBSERVATIONS BY EWING AND KLAASSEN
CURVE I — FINE STEEL WIRE
CURVE II — THICK SHEET IRON
CURVE IV — THIN SHEET IRON
CURVE V — SOFT SHEET IRON
CURVE VI — FINE IRON WIRE
CURVE VII — SOFT IRON WIRE
CURVE VIII — SOFT IRON WIRE
CURVE VIII/2
CURVES II AND III
CURVES IV AND VIII/1
CURVE VII
CURVE III
CURVE V
REMANANCE KILOGAUSSES (B)
MAXIMUM CYCLIC INTENSITY KILOGAUSSES (B)

Diagram Showing Relation Between Remanance and Maximum Cyclic Intensity.

Our attention has since been directed to the measurements of Prof. Ewing and Miss Klaassen, appearing in the London *Electrician* of April, 1895, Vol. XXXII., Nos. 829 and 830, as an abstract of a paper read before the Royal Society. Magnetic cycles are given in this paper, by the aid of curves, for eight samples of soft iron and steel.

The accompanying diagram gives the curves obtained by plotting, from the figures accompanying the Ewing-Klaassen paper, the remanance, in the various magnetic cycles, as ordinates, to their respective maximum cyclic intensities, as abscissas. Ring No. I of Fig. 4 has, however, been omitted, as there is some apparent error or misprint in its scale of ordinates, which we have not succeeded in clearing up.

The results for Ring No. II of Fig. 5, fine steel wire, are as follows:

$\mathfrak{B}$ max gausses.	$\mathfrak{B}_0$ gausses.	Calculated gausses.
15,000	12,950	13,420
12,000	10,600	10,610
10,100	8,900	8,840
8,000	7,000	6,874
6,100	5,000	5,097
4,000	3,000	3,133
1,800	1,000	1,075

These results are plotted in Curve II of our diagram as circles. The straight line

$$\mathfrak{B}_0 = 0\ 935\ (\mathfrak{B} - 650)\ \text{gausses}$$

practically coincides with all except the first or highest observation.

The results for Ring No. III of Figs. 10 and 10*a* of thick sheet iron intended for a dynamo armature are as follows:

$\mathfrak{B}$	$\mathfrak{B}_0$	
gausses.	Observed gausses.	Calculated gausses.
15,000	9,185	.....
13,750	9,000	.....
12,360	8,620	.....
11,300	8,150	8,580
9,590	7,250	7,248
7,800	6,000	5,851
5,880	4,320	4,353
3,600	2,750	2,574
1,418	760	870
300	97	.....

These results are plotted in Curve III of our diagram as crosses. It will be seen that as far as $\mathfrak{B}$ 9,600, these nearly coincide with the straight line.

$$\mathfrak{B}_0 = 0.78\ (\mathfrak{B} - 300)\ \text{gausses.}$$

Beyond $\mathfrak{B}$ 9,600, the curve declines rapidly.

The results for Ring No. IV, thin sheet dynamo iron, of Fig. 11 are

$\mathfrak{B}$	$\mathfrak{B}_0$	
gausses.	Observed gausses.	Calculated gausses.
14,300	10,500	.....
12,500	9,750	.....
10,900	8,800	.....
9,000	7,400	7,438
7,200	6,000	5,872
5,600	4,750	4,480
4,100	3,200	3,175
1,850	1,150	1,218

These results are plotted in Curve IV of our diagram as triangles. It will be seen that as far as $\mathfrak{B}$ 9,000, these nearly coincide with the straight line

$$\mathfrak{B}_0 = 0.87\ (\mathfrak{B} - 450)\ \text{gausses.}$$

Beyond $\mathfrak{B}$ 9,000 the curve declines rapidly.

The results for Ring No. V, of Figs. 15 and 15*a*, intended for a transformer core, are:

$\mathfrak{B}$	$\mathfrak{B}_0$	
gausses.	Observed gausses.	Calculated gausses.
12,250	7,400	....
11,300	7,200	....
10,100	6,900	....
9,000	6,300	....
7,500	5,600	5,570
6,100	4,600	4,464
4,800	3,500	3,437
3,200	2,300	2,173
1,250	600	632

These results are plotted in Curve V of our diagram as double circles. It will be seen that as far as $\mathfrak{B}$ 8,000, these nearly coincide with the straight line

$$\mathfrak{B}_0 = 0.79\ (\mathfrak{B} - 450)\ \text{gausses.}$$

Beyond $\mathfrak{B}$ 8,000, the curve rapidly declines.

The results for Ring No. VI (Fig. 16) of fine soft iron wire are

$\mathfrak{B}$	$\mathfrak{B}_0$	
gausses.	Observed gausses.	Calculated gausses.
11,250	9,500	9,910
9,250	8,000	8,044
7,600	6,500	6,500
6,200	5,200	5,162
4,200	3,300	3,320
1,250	500	608

These results are plotted in Curve VI of our diagram as large crosses. As far as $\mathfrak{B}$ 9,250, they nearly coincide with the straight line

$$\mathfrak{B}_0 = 0.935\ (\mathfrak{B} - 650)\ \text{gausses,}$$

which also represents Curve II, so that the remanance graph of this soft-iron wire agrees with that of the fine, soft-steel wire of Ring No. II, as far as $\mathfrak{B}$ 9,000.

The results for Ring No. VII (Figs. 17 and 17*a*) of cotton-covered iron wire are as follows:

$\mathfrak{B}$	$\mathfrak{B}_0$	
gausses.	Observed gausses.	Calculated gausses.
16,000	9,250	....
12,900	9,000	....
11,300	8,300	....
10,100	7,850	....
8,450	6,950	6,960
5,800	4,700	4,655
2,200	1,500	1,523
300	100	....

These results are plotted in Curve VII of our diagram, as squares. As far as $\mathfrak{B}$ 8,500, they nearly coincide with the straight line

$$\mathfrak{B}_0 = 0.87\ (\mathfrak{B} - 450)\ \text{gausses, of Curve IV.}$$

In other words, the remanance of this sample of soft-iron wire agrees with that of the soft dynamo iron in Curve IV as far as $\mathfrak{B}$ 8,500.

Finally, results for Ring No. VIII (Figs. 18, 18*a*, 19 and 19*a*) of soft-iron wire intended for a "Hedgehog" transformer core, are given both before and after reannealing.

BEFORE.			AFTER.		
	$\mathfrak{B}_0$			$\mathfrak{B}_0$	
$\mathfrak{B}$ gausses.	Observed gausses.	Calculated gausses.	$\mathfrak{B}$ gausses.	Observed gausses.	Calculated gausses.
15,600	10,750	....	16,000	14,400	14,750
14,200	10,400	....	15,300	14,000	14,090
13,000	9,950	....	14,900	13,500	13,700
11,600	9,250	....	13,800	12,750	12,650
10,100	8,100	....	12,600	11,750	11,600
8,400	7,000	6,916	11,000	10,200	9,982
5,850	4,500	4,698	8,600	7,700	7,688
2,350	1,400	1,653	4,000	3,200	3,295
850	250	348	1,300	700	716
			700	250	143

The observations taken before reannealing are plotted in Curve VIII*a* of our diagram, as stars, which curve practically coincides with Curve IV throughout. Consequently, as far as $\mathfrak{B}$ 9,000, the linear relation, $\mathfrak{B}_0 = 0.87\ (\mathfrak{B} - 450)$ practically applies. The observations taken after reannealing are plotted in Curve VIII*b* of our diagram as double triangles. These nearly coincide throughout with the straight line,

$$\mathfrak{B}_0 = 0.955\ (\mathfrak{B} - 550)\ \text{gausses.}$$

It is interesting to observe that the reannealing of this sample of wire apparently brought about a practically linear remanance as far as $\mathfrak{B}$ 16,000, whereas, before annealing, the remanance was only linear as far as $\mathfrak{B}$ 9,000.

Summing up the results of the observations thus far examined and collected in the following table, it appears that a linear relation exists, actually or approximately, in iron and steel, between remanance and maximum cyclic intensity. In some cases this relation exists up to 16 kilogausses of the maximum intensity; in other cases it terminates at about nine kilogausses, and falls short beyond that value.

TABLE.

Date of publication.	Volume.	Material.	Observer.	Relation $\mathfrak{B}_0$ gausses.	Observed limit of linear $\mathfrak{B}$ max gausses.
1892	Magnetic induction, etc.	Soft iron	Ewing.	0.88 ($\mathfrak{B}$— 500)	12,000
"	"	Ann. piano steel.	"	0.85 ($\mathfrak{B}$— 700)	9,500
"	"	Ann. steel.	"	1.1 ($\mathfrak{B}$— 1450)	5,500
"	"	Ann. iron.	"	1.125 ($\mathfrak{B}$— 750)	15,700
1894	*The Electrician.*	Soft steel.	Ewing & Klaassen	0.935 ($\mathfrak{B}$— 650)	15,000
"	"	Soft sheet iron.	"	0.78 ($\mathfrak{B}$— 300)	9,600
"	"	" "	"	0.87 ($\mathfrak{B}$— 450)	9,000
"	"	" "	"	0.79 ($\mathfrak{B}$— 450)	8,000
"	"	Soft iron wire.	"	0.935 ($\mathfrak{B}$— 650)	9,250
"	"	" "	"	0.87 ($\mathfrak{B}$— 450)	8,500
"	"	" "	"	0.87 ($\mathfrak{B}$— 450)	9,000
"	"	Reannealed.	"	0.955 ($\mathfrak{B}$— 550)	16,000
1895	"	Soft iron.	Ewing	0.88 ($\mathfrak{B}$— 400)	7,480
"	ELEC. WORLD	"	Fessenden	0.8 ($\mathfrak{B}$— 200)	10,000

In cycles below $\mathfrak{B}$ 500 the relation is not well sustained.

What the relation may be in hard steels, in cobalt and in nickel, we are not yet aware.

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On the Use of Magnetic Formulæ in Electrical Design.

BY REGINALD A. FESSENDEN.

At first sight there would appear to be two places where the use of magnetic formulæ would be advantageous. The first of these is in the theory of the action of the transformer; the second, in electrical design. But, as a matter of fact, the effect of the iron in the transformer, except as a means of increasing the coefficient of mutual induction, is practically nil. No matter what the shape be of the wave of impressed voltage, the waves of secondary and back voltage will have the same form. Consequently, all gibes at "ironless mathematics" are without foundation, so far as practice is concerned, and the ordinary laws of harmonic curves may safely be applied.

The reason is as follows: If the back and secondary voltages have not the same form as the impressed, then energy must be stored up in the transformer. Now, Mr. Steinmetz has pointed out that this is an extremely inefficient way of storing up energy, only about 80 per cent. of the energy stored being given back. On account of the fact that all transformers, with very few exceptions, are designed to have a high all-day efficiency and therefore have a hysteresis loss of only about 1 per cent. of full load output, the maximum amount of energy stored in the iron of the transformer cannot exceed 5 per cent. Of this, again, a large part is in phase with the current, and so the maximum variation in the back and secondary voltages from the shape of the impressed, cannot exceed about one or two per cent. This fact is well known to designers, and may be verified by examining any of the tests made on recent types of transformers. It is only at loads of one tenth of full output, or less, that the influence of the iron is perceptible. The writer has given formulæ for the induction at any instant of time, when there is such an amount of this as to render it of moment in this connection (see THE ELECTRICAL WORLD, June 7, 1894), but for the reason given above, these are of no practical importance.

Taking up next the question of the utility of magnetic formulæ in design, we have two rules which are capable of being used to great advantage. I refer to M. Steinmetz's law of hysteresis, and Kennelly's law of ferric reluctivity. (For practical purposes the ferric reluctivity is very closely the same as the reluctance, so in the following work the reluctance will be used.)

Kennelly's law is,

1. Reluctivity $= a + b\,\mathfrak{B}$

The writer has shown (THE ELECTRICAL WORLD, June 23, 1894), that this is equivalent to

2. Reluctivity $= a\,\sum_{o}^{\alpha} b\,\mathfrak{B}$

from which we get

3. $\mathfrak{R}$ (= reluctivity), $= a/(1 - b\,\mathfrak{B})$

Other deductions are

4. $\mathfrak{B} = \mathfrak{H}/(a + b\,\mathfrak{H})$
5. $\mathfrak{H} = \mathfrak{B}\,(1 - b\,\mathfrak{B})\,/a$
6. $\mathfrak{H} = a\,\mathfrak{B}/(1 - b\,\mathfrak{B})$
7. $.4\,\pi\,n\,I = \Phi\left[\frac{a\,l}{s - b\,\Phi\,k} + \frac{a'\,l'}{s' - b'\,\Phi\,k'} + \right]$

where n is the number of turns, I the current in amperes, $\mathfrak{H}$ the gilbertage, $\mathfrak{B}$ the gaussage, Φ the weberage, l and s the length and cross-section of the magnetic circuit, k the coefficient of leakage, and a and b the coefficients of the iron under consideration.

The following table of the coefficients of a number of different kinds of iron, may be of use:

	a	b
Sheet iron, sample A.	.0002375	.0000595
" " " B.	2275	654
" " " C.	3325	640
" " " D.	213	5605
Cast steel " A.	450	5125
" " B.	3140	563
Wrought iron, Hopkinson,	220	580
Mitis iron,	25	575
Cast iron,	.001031	.000129
Improved cast iron.	.0009025	.000106

To show the method of using these formulæ, suppose we wish to find what induction corresponds to a value of $\mathfrak{H} = 10$, in the case of mitis iron, we have

$$\mathfrak{B} = 10 \div (.00025 + \overline{10 \times .0000575}) = 12120.$$

So far, there is no advantage in using the formula, as the same thing could have been obtained more easily from the curve of $\mathfrak{B}$—$\mathfrak{H}$. There is this advantage, however, even here, in that to obtain the formula for any brand of iron we need only make two determinations, and from them, by the formula, we can deduce the whole curve (except for values of $\mathfrak{H}$ less than 1 or 2), instead of having to make ten or twenty different measurements. For instance, if we determine the value of $\mathfrak{B}$ corresponding to $\mathfrak{H} = 10$, and then that corresponding to $\mathfrak{H} = 20$, by substituting these values in equation 4 we can eliminate and find the values of a and b. Then, knowing these values, we can determine the induction corresponding to any other value of $\mathfrak{H}$.

The real use of these formulæ, however, is to attack more complicated problems. For instance, the following: Suppose we have a ring of mitis iron, of length 100 cm, cut in two in a plane perpendicular to the axis of the ring, so that it requires a certain pull to separate the halves. A wire, 100,000 cms long, and having a resistance of 2 $\frac{444}{1000}$ ohms, is to be wound round the ring, so that the total pull shall be 625 megadynes, and the sum of the cost of current and interest on iron and copper is to be the smallest possible, the current being supposed to be on continuously.

Let L equal the length of the magnetic circuit, s and d its cross-section and diameter, m the interest per second on one cubic cm of iron, a and b the constants of the iron, l the length of the wire, R its resistance, and p be the cost of a watt-second. Let $m = 4.10^{-11}$ and $p = 2.10^{-6}$ cents.

We have, $\mathfrak{H} = .4\,\pi\,n\,I/L = .4\,I\,l/L\,d$. Therefore

$$\mathfrak{B} = .4\,I\,l/(a\,L\,d + .4\,b\,I\,l).$$

But $\mathfrak{B}^2 s = 625.000.000$ dynes, $= h^2$, say. Therefore $\mathfrak{B} = h/\sqrt{s}$. Substituting this value of $\mathfrak{B}$ and solving,

$$I = h\,a\,L\,d/.4\,l\,(\sqrt{s} - h\,b) = 5\,h\,a\,L\,d/l\,(d\sqrt{s} - 2\,h\,b)$$

Since the amount of copper is fixed, we have, for our condition of minimum expense, $I^2 R$ loss + interest on iron = minimum, *i.e.*,

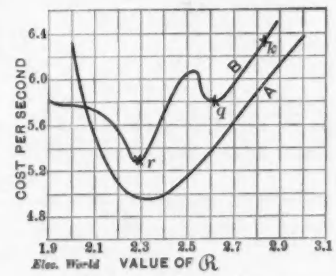
$$I^2\,R\,p + L\,s\,m = \text{minimum.}$$

Substituting value of I.

$$\left\{5\,h\,a\,L\,d/l\,(d\sqrt{s} - 2\,h\,b)\right\}^2 R\,p + m\,L\,\pi d^2/4 = \text{minimum.}$$

We can find this minimum by the ordinary calculus methods, but as, in general, in these methods we arrive at equations of a high order, whose solution is tedious and requires a larger knowledge of the theory of equations than most designers possess, it will be found better to simply plot the curve of the equation, and take the minimum or minima from it.

Curve A shows the result for this particular problem. It will be



CURVES A AND B.

seen that the most economical value for the diameter of the iron of the ring is 2.3 cm corresponding to a gaussage of 12.250.

This shows fairly well the method of using these formulæ in practical electrical design. If there had been an air gap of appreciable reluctance in the circuit, then, if this air reluctance per sq. cm of cross-section had been c, we should have written

$$\text{Reluctance} = L\,(a + b\,\mathfrak{H}) + c,$$

and proceeded as before. If it had been desired to impose certain conditions as to heating or leakage, these would have been put in the form of equations, dependant on the surface of the coil, etc., and as we would have as many equations as conditions, the solution would have been equally attainable.

In curve B, I have given a plot of another curve, which has more than one minimum. In the graphs of equations of higher orders we frequently meet such curves. This serves to show another advantage of the use of magnetic formulæ. Suppose a designer has to construct a piece of electrical apparatus, say a transformer. He chooses certain dimensions, designs a transformer to them, then alters some of the dimensions and sees if there is any improvement. He keeps on doing this till he cannot make any further improvement by changes. In other words, if he starts at the point k he works down till he comes to q, and there he stops, because he sees that if he changes the dimensions any more in that direction he gets a poorer transformer. But yet he has not really reached the best transformer, which lies much beyond, at r. He is working in a false minimum. Only the analytical method can show where the greatest minimum is, for the fact that small alterations either may make a worse transformer does not, as shown by the curve, prove that we

have reached the best dimensions. One can design the "best possible" two-phase motor or transformer by this method. Suppose we have decided that we want that transformer which will, with a given shape of load curve, have the least amount of money loss, due to interest, depreciation, copper and iron losses, per unit of power given out. We have given us the selling price of the power, the cost of copper and iron, the hysteresis constant of the iron, the reluctance constants, the watts radiated per square cm of surface, thickness of insulation on wires and between coils, and the ordinary formulæ for the voltages and currents of the transformer. It will be found, on writing these out, that we have nine unknown quantities and eight equations. Theoretically we can find the minimum of a function of two variables, but practically, in this case, we cannot, without too much trouble. But we can draw curves as before, and so deduce our transformer. If the thickness of insulation is not expressible as a function of the thickness of the wire, we must make an assumption as to its thickness, and then, when we have derived the transformer, if the assumed thickness does not correspond to the actual, we must substitute the actual thickness, and work it over again, getting our result by approximation. As a mathematical exercise these calculations are too tedious to be enjoyable, but where it is a question of actually constructing a new line of transformers or other electrical apparatus, it is believed that they will be found of value, and, though it does not by any means follow that we shall be able to design any better transformers, by its means, it still, in certain cases, may save a very considerable amount of cut and dry experiments.

The Employment of Two or Several Motors on Cars or Locomotives with Respect to Skidding.

BY PAUL HOHO.

Two or even more motors are frequently used on electric street cars and locomotives, and while certain practical conditions favor this disposition, it yet presents serious inconveniences.

Independently of the question of efficiency, which is diminished in a very great proportion, other conditions in certain cases militate against the simultaneous employment of two or several motors on the same car or on the same locomotive, or even on the same train. We will examine in this article the question more particularly from the point of view of the slipping or skidding of the wheels which can result from the combined action of the motors ; the conclusions which follow are unfavorable to this disposition in cases more numerous than would appear at first sight.

In all these dispositions each motor actuates either one axle or a pair of axles. In order to fix ideas, let us take the case of a car resting on three or four axles, of which two are motor axles, each having a motor. Each motor will experience, when the motor car or locomotive is in motion, a rolling resistance which we will designate respectively by R_1 and R_2 for the first and second motor; R_1 and R_2 thus designating the total rolling resistance offered to the motors, these resistances being considered as applied to the circumferences of the armatures of the two motors. Similarly Q_1 and Q_2 will designate the total resistance to slipping offered to the two motors, also considered at the circumference of the armatures of the first and second motor. These resistances are those which each motor has to overcome before the transmitting parts can slip, or, more particularly, before the wheels will skid. The resistances, R_1 and R_2 on the one hand, as well as the resistances, Q_1 and Q_2, on the other, may be equal, but this is not always the case. Often there are even very great differences, as these resistances are very variable in relation to each other. Not only are they variable according to the load on the motor axles, but this load itself varies according to the position the car momentarily occupies on the road, according as it is on a level, on a convex or on a concave portion of the profile of the line.

In order to estimate their importance, it is sufficient to consider for an instant, and determine the variations of, the load on the axles of a car or locomotive for three cases: First, when the portion of the road on which the locomotive momentarily finds itself is level ; second, when concave, and third, when convex. The resistances also vary according to the state of the rails, the organs of transmission and according to the position which the carriage momentarily occupies on the truck. The absolute equality of the resistances Q_1 and Q_2 practically never exist, and the difference between these resistances is sometimes very great.

The two motors are coupled either, *A*, in series, or, *B*, in parallel, whatever may be the mode of excitation of the magnetic field.

A. The Two Motors Coupled in Series. The torque at the circumference of the motor armature is equal to $K\,i\,\mathfrak{K}$, where K is a constant depending upon the motor, i, the intensity of the current and $\mathfrak{K}$, the intensity of the magnetic field. It is evident that the two motors and their gears ought to be identical for various reasons, both practical and theoretical. As the motors are in series, the intensity, i, of the current is the same for the two motors. As to the two factors, K and $\mathfrak{K}$, they are also the same, the motors being presumed to be identical, and it follows, therefore, that the torque is necessarily equal.

If everything is perfect, the motors and transmissions being absolutely identical, the resistance to be overcome by each motor being the same, everything will go well ; the current will have a normal value with a uniform speed (at least momentarily), when the intensity of the current corresponds to the following relations :

$$K\,i\,\mathfrak{K} = R_1 = R_2$$

But we have stated that the rolling resistances with respect to the two motors are variable for these, and almost always differ in a measure more or less great.

Let us suppose $R_1 < R_2$, the torque, $i\,K\mathfrak{K}$ developed by each of the two motors will then be greater for the resistance R_1 than that encountered by the first motor, and smaller than the resistance R_2 experienced by the second motor. The first will tend to accelerate the speed, the second to diminish it. But this is impossible, the two motors being necessarily restrained have in every moment the same speed.

What will happen under these conditions? The speed of the car, that is to say, of the two motors, will possibly change, but from the instant when the sum of the torques is equal to the sum of the resistances, the speed will become uniform. At that moment the resistance offered to the first motor will be necessarily equal to the torque exerted by it. Now, as these torques are equal for the two motors, it follows that the individual resistance offered to the two motors separately will be divided in a different manner, such that they will become equal to the torques exerted by these motors and, consequently, equal between them; this division follows as a consequence from the fact that the first motor tends to accelerate the speed, while the second tends to diminish it, and, consequently, the first motor encounters a resistance supplementary to its normal resistance, while the second encounters a negative supplementary resistance which diminishes the normal resistance.

From what precedes it will be seen that the new resistance, in some respects abnormal, R_1^1 and R_2^1, opposed respectively to the first and second motors becomes

$$R_1^1 = R^1{}_2 = \frac{R_2^1 + R_2^1}{2} = K\,\mathfrak{K}\,i.$$

But if the rolling resistance R_1 were less than R_2, it follows from the same cause which has led to this inequality, that the slipping of the first motor, Q_1, is less than the resistance to slipping of the second motor, Q_2. The causes lie, in fact, in the division of pressures or loads, being less on the first axle than on the second, or in frictional resistances, less in amount in the case of the first than in the second, these different resistances depending not only upon the state of the rails (which can vary from one point to another when special care is not taken), but also upon the state of the transmission parts of the two motors. Now, these same causes diminish the slipping resistance, Q_1, opposed to the first motor relative to the slipping resistance, Q_2, opposed to the second motor.

Under these conditions it can happen that Q_1 may be less than R_1^1, that is to say,

$$< \frac{R_1^1 + R_2^1}{2} \text{ and } < K\,\mathfrak{K}\,i^1.$$

In this case, the most feeble resistance, that is to say, Q_1, the resistance to slipping, is the one which will be overcome; there will be a slipping in the organs of transmission if the construction permits this; or the wheels will slip on the rails, that is to say, they will skid.

Consider now a locomotive on three or four axles of which two axles each has its own motor. If the axles are not rigidly connected —which is generally impossible for various considerations—the division of the weight is absolutely independent of the levels which these axles occupy. In a given moment one of the two motors may find itself elevated, and however feeble this may be, it will cause a very considerable diminution in the pressure on the axle. Then, whatever calculations may have been made as to the ratio of the slipping resistance to the total rolling resistances of the entire train, the normal resistance, Q_1 can very easily go below the value $\frac{R_1^1 + R_2^1)}{2}$ and skidding becomes certain.

It can be understood that the condition of skidding (Q_1 or Q_2

being less than $\frac{R_1^1 + R_2^1}{2}$) can be produced momentarily; the train will continue by its inertia for a certain distance, during which one of its pairs of motor wheels will slip while at the same time rolling, but the locomotive, having advanced a certain distance, the condition of skidding, $Q_1 = \frac{R_1^1 + R_2^1}{2}$, may cease to exist, and, in that case, the train will continue as before. This state of things can repeat itself more or less frequently.

It was remarked above that the employment of two or several motors instead of a single one will diminish the efficiency considerably. In fact, *a priori*, two or three motors of N hp give an efficiency less than that of a motor of $2N$ or of $3N$ hp. In addition, the multiplication of parts augments the frictional losses. These causes exist then, but they are not sufficient to explain, by themselves, the extraordinary differences which have been found by certain experimenters, according to which the employment of two motors of N hp in place of one motor of $2N$ hp diminishes the efficiency to an amount as high as 60 per cent. or more. These considerable losses cannot be explained otherwise than by partial slippings and skiddings frequently repeated, and which are not directly perceived. To the preceding conclusions another aggravating circumstance can be added. I have implied that the two motors have identical magnetic fields. If these fields are excited in series, or if they are excited by the same shunt current, or from currents shunted from the same points of the circuit and circulating in identical exciting coils, the hypothesis is exact; but if each motor is individually excited—partially or totally—by a shunt current taken from its own binding posts, this current is proportional to the fall of potential between the terminals. In this case, the current, and, consequently, the intensity of the magnetic field, increases with the speed of the first motor and diminishes with that of the second. Now, the torque exerted is proportional to $K\mathcal{H}$; the torque increases, then, for the motor which has a tendency to slip, and diminishes for the other, which continues at work and exerts for that reason a still greater torque.

B. The Two Motors in Parallel.—Under these conditions the operation of the two motors is still independent of each other. To overcome the resistance, R_1, the current of the first motor will have an intensity such that $K\mathcal{H}_1 i_1$, is equal to R_1; while the second motor overcoming the resistance, R_2, will have an intensity given by $K\mathcal{H}_2 i_2 = R_2$. But under these conditions the speed will be, respectively, for the first motor,

$$n_1 = \alpha \frac{e_1}{\mathcal{H}_1} = a \frac{E - T_1 i_1}{\mathcal{H}_1},$$

and for the second motor,

$$n_2 = \alpha \frac{e_2}{\mathcal{H}_2} = a \frac{E - T_2 i_2}{\mathcal{H}_2},$$

where E is the total E. M. F., e_1 the E. M. F. of the first motor, e_2 the E. M. F. of the second motor, r_1, the electrical resistance of the first motor, r_2, the electrical resistance of the second motor, $\mathcal{H}_1$, the intensity of the magnetic field of the first motor, $\mathcal{H}_2$, the intensity of the magnetic field of the second motor, and α a constant depending on the motor.

We have here three cases to distinguish: 1. The motors are excited in series. 2. The motors are excited in shunt. 3. The motors have a compound excitation.

1. In the first case the intensity of the magnetic field will be a function of $\mathcal{H} = \mathcal{H}_{sat} \times \frac{Ni}{Ni + h}$ and, therefore, essentially variable, $\mathcal{H}$ being the intensity of the magnetic field when saturated, Ni the number of exciting ampere-turns, h a constant equal to the number of ampere-turns which produce half saturation (critical point).

The speeds become, respectively,

$$n_1 = \alpha \frac{(E - r_1 i_1)(Ni + h)}{\mathcal{H}_{sat} N i_1}; n_2 = \alpha \frac{(E - r_2 i_2)(Ni_2 + h)}{\mathcal{H}_{sat} N i_2}.$$

The speeds of the two motors would thus be essentially different, since the resistances offered are different. But the motors are forcibly constrained to the same speed; from which it follows, having given the preceding relations (where n_1 becomes $= n_2$) i' will become i'', the two motors will exert the same torque, and, as in the preceding case, A considered, the resistance to be overcome will be equally divided between the two motors, or

$$R_1^1 = R_2^1 \frac{R_1^1 + R_2^1}{2}.$$

It is to be remarked that thus far we have arrived at the same conclusion as with two motors in series, though the fundamental causes are exactly opposite. Here, happily, the similarity between the two cases ends.

Continuing the same notation as precedes and the same hypotheses, suppose that the resistance to slipping, Q_1, becomes at a given moment less than R_1^1, that is to say, less than $R_1^1 + R_2^1$. The first motor will encounter a less resistance to slipping than to rolling, and there will be slipping and skidding, at least partial. It will continue in motion on account of the inertia and the torque of the second motor, but it will not in itself act to overcome the rolling resistance. The second motor then will encounter the total rolling resistance.

Now, here the current acts on second motor entirely independently of the first, which distinguishes this case from that of case A; it will become the value $i_2^1 = K\mathcal{H} i_2^1 = R_1 + R_2$; that is to say,

$$K\mathcal{H} i_2 = \frac{K i_2^1 \mathcal{H}_{sat} N i_2}{N i_2^1 + h} = \frac{K \mathcal{H}_{sat} N i_2^2}{N i_2^1 + h} = R_1^1 + R_2.$$

The speed will be

$$\frac{n_2^1 = (\alpha E - r_2 i_2^2)(N i_2^1 + h)}{\mathcal{H}_{sat} N i_2^1}.$$

The current will be increased, the speed will diminish, both in a proportion which depends principally on the saturation of the magnetic field, but it is not a case of complete slipping, as in case A.

The difference between the two cases, A and B, will be remarked; that is to say, when the motors are coupled in series or in parallel. In case B, when slipping is produced, one or other of the motors increases its torque in order to overcome the total resistance which it has to encounter independently of the first motor; while in case A, when either motor is subjected by slipping to a resistance less than the normal resistances, all the other motors are affected by the feeble resistance, and tend to stop in unison with the resistance which they encountered themselves, permitting the first motor to turn alone, whether at rest or at any speed.

With the motors disposed of in parallels, cases of *partial* slipping are not excluded, as we have seen.

2. When the magnetic fields of the motors are excited in shunt, the intensity of these fields is constant, or at least very approximately, so $\mathcal{H}_1 = \mathcal{H}_2$ whatever may be the value of i;

$$n_1 = \frac{E - r_1 i}{\mathcal{H}_1}; n_2 = a \frac{E - r_2 i_2}{\mathcal{H}_2}.$$

In examining this case from the purely theoretical point of view, figures not being considered, the same result is arrived at with respect to the mode of operation as in the preceding case, but in reality the values of r_1, i_1 and r_2^1 and i_2^1 which constitute the loss of E. M. F. in the armatures of the motors are always very small compared to E, and consequently the counter E. M. F. and the speed vary very little when the intensity of the current varies; the effect of the differences of intensity on the speeds of the two motors is, besides, so small that it is often compensated for in part by small inequalities of construction which may exist, or differences in the quality of the iron in the magnetic field, or heating of the motors varying the resistance of the copper. These small differences, on the other hand, and for the same reason, lead very easily to differences of intensity between the motors which may be notable, so that one of the motors may work under a greater load and the other under a less load.

3. Compound-excited motors possess the combined properties of motors excited in series and in shunt. It is then easy to take account of their working. From the point of view which we have here taken, they will hold a position midway between the two other classes of motors.

C. Very often the two motors are connected to a controller combined in such a way that it permits their being put in series or in parallel. This combination permits the speed to be varied in a manner depending upon the method of excitation and upon the saturation of the magnetic fields, and this circumstance even constitutes one of the reasons which often leads to the employment of two motors. However, means for varying and regulating speed are not lacking.

To resume, the employment of two or of several motors on the same car, on the same locomotive, or on the same train, may result, in certain cases, notably when the roadbed is not well cared for, in very serious inconveniences with respect to slipping and skidding. It is true that there are often conditions, such as the dimensions of motors, which render this subdivision necessary. In these cases there should be no doubt as to the manner of grouping the motors, which should be in parallel; and, besides, it is necessary to take all the precautions possible with respect to the division of the load on the axles and the design of the transmission parts, in order to avoid partial slipping.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

Note.—Typewritten copies of any of the articles referred to in the Digest, will be furnished at the rate of 5 cents per 100 words for English matter, and 8 cents per 100 words for matter in foreign languages; translations at the rate of 40 cents per 100 words. Copies of any of the journals may be ordered; address Branch Office, ELECTRICAL WORLD, No. 527 Chestnut Street, Philadelphia, Pa.

DYNAMOS, MOTORS AND TRANSFORMERS.

Investigation and Design of Alternate-Current Dynamos.—The Lond. "Elec.," July 26, contains a discussion of this subject by Dr. Behn-Eschenburg. The method of treatment is somewhat similar to that in an article by the same author published in THE ELECTRICAL WORLD, June 29, p. 742.

Theory of Single-Phase Motors.—The "Elek. Zeit.," July 25, contains an article by Mr. Cahen in which he applies to single-phase motors the results which he deduced in a previous article (see Digest, Feb. 16 and 23), for multiphase motors; he adds that more complete and exact experiments will be required before the principles which he gives can be used in a theory for the practical predetermination of such motors; he states that the purely analytical calculations of Dr. Behn-Eschenburg lead to very complicated calculations.

Theory of the Synchronous Motor.—The Physical Society paper by Mr. Rhodes is apparently concluded in the "Phil. Mag." for August.

High-Tension Laboratory Dynamo.—A translation of the article which was abstracted in the Digest, Aug. 3, is published with the illustration in the Lond. "Elec. Eng.," Aug. 2.

Design of Transformers.—The article of Mr. Adams (see Digest, Aug. 10), is concluded in the Lond. "Elec. Rev.," July 26 and Aug. 2; it does not admit of being abstracted; it is written in an easily understood style, and the formulas are all of a simple and practical nature.

Relations between Pressure, Resistance and Friction of Brush Contact.—The "Elec. Eng.," Aug. 7, reprints a thesis by Messrs. Cox and Buck, describing in detail a series of experiments made to determine these relations; the apparatus is illustrated and a number of curves showing the results are given. The resistance of contact was measured by the fall of potential method while the normal pressure and the tangential pull were measured by delicate spring balances; a current was passed through the brush and a revolving cylinder, which in some cases was an iron pulley and in others a copper commutator; the curves represent the averages of a large number of measurements. From the results they arrive at the following conclusions: the contact resistance does not vary inversely as the pressure, for beyond a certain point a great increase in pressure produces but a slight diminution in resistance; this critical point occurs at different pressures for different brushes; the contact resistance of carbon is much higher than that of copper; it is less on a cast-iron pulley than on a copper commutator; slight oiling increases the contact resistance only slightly; the tangential pull is directly proportional to the pressure; slight oiling greatly diminishes the friction; for the same pressure the friction is less on cast-iron pulleys than on copper commutators; the friction of a copper brush is greater than that of a carbon brush at the same pressure; the friction of a radial carbon brush is greater than that of a tangential one at the same pressure; the friction of all brushes is slightly less at high than at low peripheral speeds. The most advantageous pressure for a given brush will depend largely on the relations existing at the different pressures between the loss of electrical energy due to the resistance and the mechanical work consumed by friction; an example is worked out showing that 0.042 hp is the power lost in friction and 0.07 that lost in resistance; the brush was a carbon one placed radially with a pressure of 24 oz. and a current of 20 amperes; the ohmic resistance was 0.13 ohms and the tangential pull 23.5 oz.

Induction Motors.—"Elec. Power" for August begins the publication of answers to a number of technical questions regarding the principle, action and construction of such motors; the present issue contains answers by Mr. Steinmetz.

LIGHTS AND LIGHTING.

The Electric Arc.—The serial by Mrs. Ayrton (see Digest, April 6), is continued in the Lond. "Elec.," July 26. In the present portion the equation connecting the volts, amperes and length of arc is developed. It was decided to study the problem under the simplest conditions and therefore nothing but solid carbons were used, the positive carbon being 11 mm and the negative 9 mm in all cases; the "Apostle" carbon was used throughout. Special attention was given to three points, first the true equation connecting volts, amperes and distances between carbons after the potential difference had in each case reached its steady value for the particular current and length of arc employed; secondly, the drop of potential difference between the positive carbon and the arc and between the arc and the negative carbon; and thirdly, the real shape and size of the carbon as compared with its visible shape and size; the present portion is devoted to the first of these. At first it was found that from the data obtained, there were two equations either of which might be correct, one of these was the equation of a series of ellipses and the other of hyperbolas; if they were real ellipses no current less than about four amperes ought to be able to maintain an arc continuously with the carbons used, whereas if they were hyperbolas any current however small ought to maintain an arc provided a large enough voltage was used; at first it seemed as if the ellipse equation was the correct one, but she found that currents of two amperes could be kept flowing, long enough for the voltage to become perfectly steady although it took between one and two hours; she showed that the curves were not ellipses; further experiments were made to find whether they were really hyperbolas or only approximations; a large number of points were obtained; in developing the equation it was found best to connect the power with the apparent length of arc for various constant currents and the results were then found to be a series of perfectly straight lines as shown in Fig. 1; by connecting the power and the current for various constant lengths of arc a series of perfectly straight lines were also obtained, two of which are shown in the accompanying Fig. 2. The final equation for the particular carbons used is as follows:

$$V = 38.88 + 2.67l + \frac{11.66 + 10.54l}{A}.$$

To check this equation a large number of results were calculated and determined by experiment, showing an excellent agreement; a table of these figures is given and it is concluded that there can be no doubt that this equation gives the law accurately for these carbons; the general form of this equation is:

$$A \left\{ V - (a + bl) \right\} = c + dl;$$

this is the equation of a rectangular hyperbola when l is constant and one of the asymptotes is the axis on which the voltage is measured, while the other is a line parallel to that along which the current is measured; it is explained why these curves are really rectangular hyperbolas although they do not appear so.

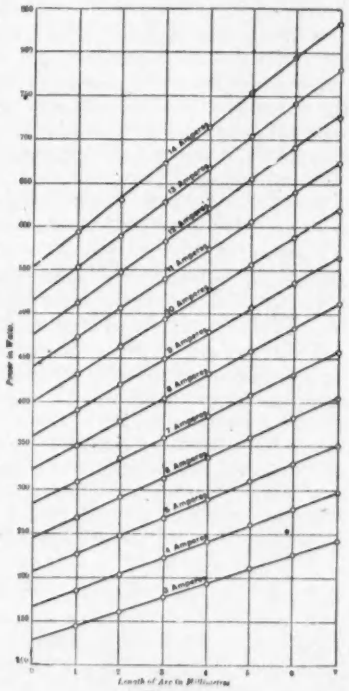


FIG. 1.

Tests of Incandescent Lamps.—The paper of Profs. Ayrton and Medley, which was abstracted in the Digest, May 25, is published in full with illustrations and curves in the Lond. "Proc. Phys. Soc." for July.

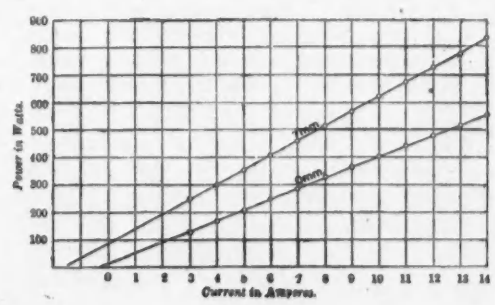


FIG. 2.

Intrinsic Brilliancy of Lamps.—Mr. von Oechelhaeuser in the "Gas World" states that a Welsbach lamp gives one candle for every 33 sq. mm of its area; according to Bernstein an electric incandescent lamp gives one candle for each 4 sq. mm.

Projectors.—A further communication by Mr. Nerz (see Digest, July 27), is published in the Lond. "Elec. Eng.," Aug. 2; it does not appear to contain anything of importance.

Inverted Arc Lamps in Cotton Mills.—A letter by Mr. Goff, read at the New England Cotton Manufacturers' Association last Spring, is reprinted in the "West. Elec.," Aug. 3; he refers to the mill at Pawtucket, R. I. Forty-two inverted arcs have been in use during the past Winter, and next Winter it is intended to equip the entire works with such lamps; he finds that the cost of installing 100 incandescent lights or their equivalent illumination in arc lamps, is about the same; the cost of maintaining the arcs is about the same as that of the renewals of the incandescent plant; they have been using incandescent lights for nearly 15 years, and as far as cost and illumination are concerned they prefer gas; the inverted arc, the light of which is reflected from a white ceiling, gives a soft, mellow light, evenly diffused, and he considers it the ideal system for mill lighting; he believes it produces a far better illumination for much less money than lighting by incandescent lamps or gas; one can see more and better by reflected light than by an open light, which he explains by the fact that the hidden light allows the pupil to expand, thus enabling the eye to see more with the same or less actual quantity of light. He gives results of comparative tests made in January; the braiding room, in which the first test was made, is 136 feet long, 66 feet wide and 12 feet high; it was formerly lighted with 84 gas jets, and it is now better lighted by eight inverted arc lamps which are run two in series on the continuous-current system, each pair taking nine amperes; a test during 2.5 hours showed that gas at $1.50 cost $2.83, while that of the eight arc lamps consuming 9,900 watts at 15 cents is $1.48, showing a difference in favor of the arcs of $1.33, or a saving of 47 per cent.; in another room a similar test showed a saving of 33.3 per cent., while the room is now better lighted by 10 arcs than it was with 32 gas jets.

Cost of Street Lighting with Arc Lamps.—Mr. Gleaves in a letter to the "Eng. News," Aug. 8, suggests that it would be interesting to know the details making up the low cost of $41 per annum which was recently published in that journal as the result of a 100-light municipal plant; he has investigated several municipal stations where the public statements of cost range from $29 to $60 per lamp per year, and he invariably found the statements erroneous; in a recent case the cost in a municipal plant was said to be $36.50 per year, yet a careful review of the appropriations chargeable to light showed the cost to be not less than $77 after deducting the revenue from commercial services; he claims that interest and depreciation are rarely considered and many incidental expenses are lost sight of in the general accounts of city governments.

Electric Lights in Mines—The "Mining Journal" publishes some recent results obtained by Dr. Haldane, which are given in abstract in "Elec. Power" for August. They refer to the presence of black-damp; he finds that when the percentage of oxygen has fallen to 17.64 a candle is extinguished, at 3.38 per cent. of carbonic acid gas and 15.3 per cent. of oxygen his respiration began to deepen, and at 7.32 and 9.6 per cent. respectively there was violent panting; at 7 per cent. of oxygen consciousness would probably have been lost. He thus shows that there is a wide margin between the point of the extinguishing of a lamp and the point of danger to life; a miner provided with an electric lamp could therefore penetrate with impunity or escape through atmospheres containing at least three times as much black-damp as would extinguish a lamp and the difficulty of respiration would give ample warning if the electric lamp did not.

POWER AND HEAT.

Producer Gas Motors and Electrical Power Transmission.—The Lond. "Elec. Rev.," July 26, publishes a translation from the French of the description of the plant at the chemical works of Mr. Linet at Aubervilliers, which was mentioned in the Digest, June 22; it is termed "a remarkable application of electrical driving of machinery." The results of tests are given and show a consumption of 1.5 lbs. of fuel per brake hp and 1.12 per indicated hp, but as they refer to the French hp the results should be increased by about 1.5 per cent. to reduce them to English hp. "There appears to be now a considerable accumulation of producer gas results to support the claim that gas engines are certainly cheaper to work than steam engines, while they avoid the danger of the steam boiler. The question of durability alone seems now to be the point at issue."

Electric Heating.—In a communication to the "Elek. Zeit.," July 25, Mr. Helberger calculates that the average efficiency of the Crompton apparatus for heating water is only 63.50 per cent. while the Helberger apparatus, as determined by an institution in Munich, averaged 87.64 per cent. Regarding heaters for warming rooms he claims that the figures given by Crompton, namely, 5 amperes at 100 volts for heating an ordinary room, cannot possibly be correct; he made experiments himself with heaters imported from England and found that a sheltered room of 25 cb. m capacity in winter when the temperature of the outside air was —10° C., was heated in five hours to +5° C, showing that this heater is absolutely incapable of heating such a room; his researches show that 50 watts are necessary per cb. m of space in such rooms; for a room of 30 cb. m and a cost of five cents per kw-hour, the cost of the current for heating would amount to about eight cents per hour, which few would be willing to pay, and he concludes that the electrical heating of rooms is practicable only when the cost of current is much less than the above figure.

Three-Phase Coal Cutter.—The "Eng. and Min. Jour.," July 20, published an illustrated description by Mr. Sprague of a coal cutter recently introduced in the Davis mines in West Virginia, and which is claimed to be the first application of three-phase apparatus in electric coal mining work. It was built by the General Electric Company. The voltage of the generator is 550; the coal cutter is of the general type and makes a cut three feet wide by six feet deep in about 3.5 minutes withdrawing in 0.5 minutes, the height of a cut being 4.5 inches; at the present time it is showing a rate of cutting averaging over 200 lineal feet of face undercut six feet deep in ten hours; the motor is an iron-clad induction motor. A peculiarity of the motor has been made good use of in this application, namely, its refusal, unlike a direct-current machine, to do more work than it can properly be called upon to do; a direct-current motor when very much overloaded will be apt to be injured; a large portion of breakages in coal cutting work is said to be due to the knives striking foreign substances; the present motor when overstrained above a pre-determined amount will simply stop; the repairs have been absolutely nothing during the several weeks of its operation; the capacity of the motor is 20 hp but the power actually consumed in ordinary coal is 6 to 7 hp.

Electric Coal Cutting.—A description by Mr. Mitchell of his machine and its operation as compared with hand working, is given in the "West. Elec.," Aug. 17. For his machine four men are required; it has regularly cut 420 feet in length and 3 feet deep in 10 hours; comparative costs of operating are given and they show that there is no saving, but there are other points to be considered beside the actual cost; there is less dross and larger coal produced; there is a much larger output from the faces; there is very little difference in the first cost between plants operated by compressed air and by electricity.

Niagara Falls Power Plant.—"Elec. Eng'ing" for August contains a long illustrated article by Mr. Abbott giving a brief description of the plant and discussing the question of the cost of power; he concludes that after making all due allowance, there is apparently a very large radius over which Niagara energy may be remuneratively delivered in competition with the very best designed and most economically administered steam plants. "Notwithstanding that it is possible to show that Niagara power is cheaper than that of home manufacture and is accompanied by collateral advantages, it will require a generation to accomplish its introduction to any notable extent."

Long-Distance Power Transmission.—The "Eng. News," Aug. 1, states that a power transmission plant is proposed at Los Angeles, Cal., in which power is to be transmitted 105 miles from the Kern River; the scheme contemplates the transmission of 10,000 to 40,000 hp.

Heating Cars by Electricity.—An order recently issued in Massachusetts, reprinted in the "Elec. Eng.," Aug. 14, requires that the electric railway companies in that State shall heat their cars electrically during November, December, January, February and March, whenever the outside temperature is less than 50 degrees F.; the inside temperature shall not be less than 50 or more than 60 degrees F.; regulations are to take effect in November of this year.

TRACTION.

City & South London Railway.—The Lond. "Elec.," Aug. 2, states that according to a recent official report the locomotive expenses per train mile are now 12.2 cts. as against 12.44, while the receipts have grown from 51 cts. to 52.2 cts.; the northern extension of this line is being started and it will result in the running of heavier trains.

Electric Railways.—In a continuation of the profusely illustrated article of Mr. Pellissier in "L'Eclairage Elec.," July 27, he gives illustrated descriptions of a number of systems, among which are a large number of conduit systems; the descriptions and illustrations appear to have been taken from patent specifications, and a number of them are of American origin.

Electricity on Steam Roads.—The Lond. "Elec.," Aug. 2, states that plans have been prepared for converting the Hamburg-Harburg section of the Prussian railway into an electric line.

Burlington & Mt. Holly R.R.—Some of the data regarding this road, which was opened July 22, and on which electricity is replacing steam, are given in the "St. Ry. Jour." for August, "Elec. Rev.," Aug. 7, and "Elec. Eng.," Aug. 14. The length is 8 miles; there are 10 trains each way; span wire construction is used throughout; the poles are all wood and carry the feeders; the trolley wire is 22 feet above the rail; there are 2 feeders of 500,000 cm each, one running the full length and the other three quarters of the way; the trolley wire is No. 00 hard drawn copper; the track is the same as that for steam roads; it is bonded, and there is a supplementary wire along each side; the power plant located at the Mt. Holly end consists of a direct-coupled generator of 300 hp; there are 3 motor cars drawing standard railway coaches for trailers and maintaining a speed of 45 to 60 miles an hour; the motor cars are slightly smaller; the wheels are 36 in. in diameter; there are 2 motors of 75 hp each on each

car, although the first car was equipped with 4 motors of 50 hp; the cars are equipped with air brakes operated by a small motor which is regulated automatically.

Electric Locomotive.—Referring to the Heilmann locomotive Mr. Eames in the "Elec. Ry. Gaz.," Aug. 10, suggests that on such a locomotive a high-speed impulse steam turbine coupled directly with a high-speed generator might be used to advantage; such a generator should have all the advantages of the Heilmann construction while it would avoid the excessive weight; the electric apparatus might then be regarded simply as an ideal form of speed reducing gearing.

Hydraulic Gearing for Electric Cars.—"Elec. Eng.," Aug. 7, publishes a well illustrated description of the Dey-Griswold gearing, the object of which is to gear the motor with the axle at variable speeds and to enable a single motor to be used. In the single motor both the field and armature revolve; it has ten poles, one field coil and four brushes, and the field is shunt wound; they have separate shafts, and on each is placed a pump having four radial cylinders, all of which are single acting and attached to one crank pin, which may be adjusted to any distance from the centre from 0 to 1.5 inches to either side, thus varying the pumping capacity; the axles contain fluid motors; the liquid used is oil; the fluid motors may be made to drive the motor, thus returning power on grades and replacing the brakes; when the crank pin is at its centre the wheels cannot turn, although the motor is running continuously; with a small eccentricity a very great starting torque is obtained; there are only two valves in the apparatus, one on each pump; the whole arrangement is operated by a crank handle on the platform. From the statement that the company "proposes to build a 20-hp outfit to begin with," it appears that no practical trials have yet been made. Among the advantages claimed are, besides these above mentioned, a high efficiency, saving in many cases 50 per cent. of the current, due partly to the use of a shunt motor; the large percentage of power returned to the line on down grades and stoppages; and a reduction of 1.25 tons in weight, as compared with the usual double motor equipment.

Series Parallel Arrangement with Single Motor.—The Wightman motor is illustrated and described in the "Elec. Eng.," Aug. 7; its object is to enable a series parallel regulation to be used with cars on which there is a single motor. The motor has four poles forming the ends of two independent magnets; two adjacent poles are wound with series coils and the two others have no winding; there are four brushes; the motor is first operated as a two-pole machine with the two halves of its armature in series, and then in combination with a shunt around half of the motor when it operates as a four-pole motor with the two halves of the armature in parallel; two brushes diametrically opposite to each other are always active and the other two are used as negative brushes when the motor is operated as a four-pole machine; when the current passes in series through the two halves of the armature both of the wound poles are magnetized in the same sense but in the other case the four poles alternate in polarity.

Combined Three-Wire and Booster Railway System.—An arrangement devised by Mr. Henry is illustrated in the "Elec. Eng.," Aug. 7; the object is to supply the line with different voltages for different sections. The system consists of a three-wire circuit supplied by two generators of different voltages, the line being divided into insulated sections which are connected to that generator which produces the voltage suitable for that section, the rails forming the neutral conductor; he suggests 400 volts for down grades and for sections where the speed is slow, and 650 volts for up grades and suburban districts. The shunt coils of the two compound generators are connected in series with each other, which, he says, is essential when constant potential dynamos of different voltages are connected in series.

Conduit Roads.—A description, by Mr. Connett, with some good illustrations, of the Metropolitan Railway in Washington, is published in the "St. Ry. Jour." for August. Regarding the cost, he states that no final estimates on actual figures can be given at present, but those based on the actual contract price show the cost to be $34,811 per mile; this is for a straight single track, but does not include ducts, drains, special track work, etc., or extras; it includes repaving, which amounts to about one third of the total.

The Love system as used on the Third Avenue Railway in New York is described and well illustrated in the same issue.

Test of an Electric Railway.—A paper read by Mr. Johnson at the Electrical Section of the Franklin Institute is reprinted with the illustration and table in the "Elec. Ry. Gaz.," Aug. 10. He describes some rough tests which he made on a line in Richmond five years ago. They show the electric economy that could be gained by a continuously running motor and the necessity of the electrical engineer studying the local conditions in proportioning the feed system of a railway.

Central London Railway.—A brief description, with some illustrations, of this tunnel road is published in the "St. Ry. Jour." for August.

Electricity on Steam Roads.—According to a Chicago daily paper the Chicago & Northern Pacific is about to substitute electricity for steam on its line; it will be the first road in the West to use electricity; it is expected that the steam locomotives will be abandoned within four months; a brief account but containing no technical data is published in the "Elec. Rev.," Aug. 7, and the "Elec. Eng.," Aug. 14.

Electric Railways in Europe.—A table giving the mileage and number of cars of all the roads, which was mentioned in the Digest, July 27, is reprinted in the "Elec. Age," Aug. 17.

New Jersey Electric Railway Company.—A well-illustrated description of this system which is said to be one of the most extensive in New Jersey and ranks among the longest interurban lines in the country, is published in the "St. Ry. Jour." for August.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Efficiency of Electrical Installations.—In a long illustrated article by Mr. Bochet in "L'Eclairage Elec.," July 20, he gives tables of results for a number of stations in the United States, from a recent paper by Mr. Delahaye, and finds that the best result is 578 watts per kg of coal in a station whose total output is 229.68 kw-hours; he compares this with an installation at the terminal of the Sceaux railway in Paris having a total output of 987 kw-hours, the efficiency of which was 596 watt-hours per kg, a result that was obtained from a very careful series of tests; he concludes from this that this result is better than the best obtained in the United States. This is followed by a long illustrated description of that plant in which continuous currents and a three-wire system are used in conjunction with accumulators; the installation consists of 96 arc lamps, about 500 incandescent lamps and a number of motors.

Gas Engine Stations.—In the continuation of the series of articles in the Lond. "Elec.," July 26 (see Digest, July 20), a long and well-illustrated description of the Belfast station is given; a description of the station was published in THE ELECTRICAL WORLD, May 18, page 581.

Gas Engine Station.—The article abstracted above from the Lond. "Elec." is reprinted in abstract with a number of the illustrations in the "Elec. Eng.," Aug. 14.

WIRES, WIRING AND CONDUITS.

Loss of Voltage in Alternating-Current Lines.—"L'Ind. Elec.," July 25, contains the first part of an interesting article by Mr. Rodet in which he discusses, with the aid of comparatively simple formulas and graphical methods, the loss of voltage in lines carrying single and polyphase alternating currents. Having given a line for transmitting a certain power at a certain initial voltage and a percentage loss of the power, he shows how to calculate the voltage at the end of the line, or inversely, to determine the size of the conductor, so that the loss in volts shall be a given amount; the results are given in the form of a table. The article does not admit of being abstracted; his conclusions are as follows: The loss of voltage in a line transmitting an alternating current is practically independent of the angle of phase difference between the current and the voltage at the generator end; it is equal to the loss of voltage which would take place in that line if the power were transmitted in the form of a continuous current of the same voltage; the relative loss of voltage in the line is practically equal to the product of the relative loss of power and the square of the power factor; in the particular case in which the angle is 45 degrees, the percentage loss in volts is equal to half of the percentage loss in watts.

Asphalte Cables.—According to the Lond. "Elec.," July 26, Mr. Goerz states that the whole underground network of the St. Petersburg electric supply station consists of lead-covered "asphalte" Siemens & Halske cables, which have been worked for the past six or seven years with entire satisfaction; the cost of repairs and renewals for the past year was only 0.5 per cent. of the total expenditure.

ELECTRO-PHYSICS AND MAGNETISM.

Sparking Distance.— The Lond. "Proc. Phys. Soc." for July abstracts an article by Mr. Jaumann, from the "Wien. Ber.," 104, p. 7. He points out that the spark length is not a simple linear function of the potentia between the terminals, but is determined by the material of the electrodes, the nature of the dielectric and the time rate of change of the potential; if the conditions are such that the inevitable oscillations are very great or rapid there will be very little variation in the potential corresponding to a given gap; this is realized approximately when an influence machine is used as the generator; with weaker discharges he finds that the potential may be as much as four times the value calculated from the length of the gap. The passage of sparks may sometimes impair and sometimes improve spark transmission; small sparks are more susceptible to changes than large ones; he shows that these effects are not due to the presence of dust; the unstable condition of the spark gap is associated with the phenomenon of the discharge of an electrified body by the action of light; if care is taken to avoid rapid fluctuations of potential it is generally possible to attain a very high potential before a spark jumps the gap; there is a retardation akin to the lag in the boiling and solidification of certain liquids.

Velocity of Electric Waves.—The "Phil. Mag." for August contains a long paper by Profs. Trowbridge and Duane in which they describe their researches with the direct measurement of the velocity of electric waves; they believe that no descriptions of a direct measurement have yet been published; the present paper contains the results of more recent determinations than those which they published not long ago and they are more in accord with the theory. The average value of the velocity in centimetres per second was found to be 3.003 multiplied by 10 to the 10th power. From their best results it appears that the velocity of measured waves among two parallel wires differs from the velocity of light by less

than 0.2 per cent. of its value; theoretically the velocity along a single wire should be approximately that of light and their results therefore in a certain sense confirm the theory to an accuracy within their probable error; theoretically it should be equal to the ratio of the two systems of electrical units, the average of the best measurements of which is 3.001 which is nearer the average velocity obtained by them than the velocity of light.

Thermoelectric Power and Elongation of Magnetized Iron.—A paper by Mr. Bachmetjew from the "Wien. Ber.," 104, p. 71, is abstracted briefly in the Lond. "Proc. Phys. Soc." for July. He shows that the thermo-electric force between magnetized and non-magnetized iron is proportional to the square of the magnetization for moderate fields; Nagaoka has shown that the magnetic elongation follows the same rule; these two quantities are therefore proportional to one another; the thermo-electromotive force in a magnetized wire varies from zero in the middle to a maximum at about 15 per cent. of the length of each end and falls off again a little toward the end; then elongation, and therefore the internal work done must vary similarly.

Influence of Circular on Axial Magnetization.—A paper by Mr. Klemencic from the "Wien. Ber.," 104, p. 86, is abstracted as follows in the Lond. "Proc. Phys. Soc." for July: The magnetization and hysteresis curves of thick iron and steel wires were taken by the customary methods when the wire was carrying a variable current. The mean circularly magnetizing field thus produced varied from 0 to 15 units. It was found that circular magnetization diminished the induction produced axially, but by an amount not proportional to the circular field nor proportional to the normal axial induction; the effect is greatest near the point of inflection of the magnetization curve, where it may amount to 75 per cent. diminution in soft iron and 15 per cent. for steel. The hysteresis curves are similarly flattened; the loss of energy in a cycle being slightly diminished the retentivity much diminished (for iron) or slightly (for steel), while the coercive force is nearly unaltered.

Magnetism of Asbestos.—The short paper of Mr. Bleekrode, which was abstracted in the Digest, Aug. 3, is published in full in the "Phil. Mag." for August.

An Electromagnetic Effect.--The paper of Mr. Bowden, which was abstracted in the Digest, April 2, is published in full with illustrations in the "Phil. Mag." for August.

Capacity of Electrolytic Condensers.—An article by Messrs. Sheldon, Leitch and Shaw, abstracted in the Digest, June 28, is reprinted in the "Elec. Rev.," Aug. 14.

ELECTRO-CHEMISTRY AND BATTERIES.

Persulphuric Acid and Chemical Reactions in Accumulators.—The Lond. "Elec.," July 26, gives a translation in abstract of a recent article by Messrs. Elbs and Schoenherr from the "Zeit. f. Elek. u. Electrochem.," 1895, pp. 417 and 468. The apparatus for studying the formation of persulphuric acid consisted of a beaker containing a porous cell surrounded by a sheet of lead as a cathode, the anode being platinum wire or foil; the temperature was kept at 8 to 15° C. by cooling with ice; the theoretical yield per ampere-hour is 3.63 grammes of persulphuric acid; very little was formed with solutions whose density was below 1.2; the E. M. F. was 5 volts and the current density 100 amperes per square decimetre of anode surface. The yield was largest in the first hour and a density of 1.450 gave the best results; certain conditions must be fulfilled for the formation of this acid as the residues react upon water forming sulphuric acid and evolving oxygen; a high current density is therefore required. The yield does not increase as the density increases, but it begins to fall off at the specific gravity of 1.5; they consider that their results support Kuester's theory that the electrolytic formation of persulphuric acid is due to the union of HSO_4 ions and not to oxidation; there is a limit to the amount formed, as it is a very bad conductor and forms an almost insulating sheath around the anode if formed too rapidly; the yield decreases rapidly with the temperature and at 60° C. it decomposes almost as soon as it is formed. They discuss the bearing of these results on the theory of Mr. Darieus (see Digest, June 8), that the formation of persulphuric acid during the charge converts the lead oxide and lead sulphate of the positive plate of an accumulator into peroxide, the completion of charge being denoted by the decomposition of any excess of persulphuric acid into sulphuric acid and oxygen; they show that the results of their experiments are not in accord with this theory, for with the low current densities in accumulators very small quantities of this acid would be formed even with the high specific gravity of 1.3; with a current density of 2,800 amperes per sq. m. such acid was found to give 24 per cent. of the theoretical yield, while with 1,300 the amount could be only just detected; the current densities in accumulators is very much lower being in a certain case only 5 amperes per sq. m. They show that lead and lead sulphate are not converted into peroxide by solutions of sulphuric acid containing persulphuric acid, however concentrated they may be, but that a clean lead plate sulphates more rapidly in such solutions while peroxide of lead is reduced. They admit that persulphuric acid is occasionally found in charged accumulators, but they regard it only as an accidental and secondary product. Editorially it is stated that Mr. Robertson made experiments with actual accumulators and was the first to suggest that an important part was played by the reactions occurring in the acid; he found that hydrogen peroxide was the principal oxidation product in cells containing acid of a density of 1.18, while persulphuric acid was the chief constituent in those containing acid of a density of 1.2. Regret is expressed that the experiments of Elbs and Schoenherr were not made on cells in commercial use. Messrs. Gladstone and Tribe found that with low current density, lead sulphate was the sole product on the positive plate, while by diminishing the strength of the acid and keeping the current constant the formation of lead peroxide nearly ceased, a white substance supposed to be basic sulphate taking its place.

Chromic Acid Batteries.—Prof. Hammerl recently made extended experiments with different mixtures of water, sulphuric acid and chromic acid in order to determine the best mixture which corresponds to the smallest consumption of zinc and the greatest amount of electrical energy, the results of which are given briefly in the "Elek. Zeit.," July 25, and are as follows: 1,200 grammes water, 300 grammes sulphuric acid (no density is given) and 659 of commercial chromic acid. (No data regarding the rate of discharge of the cell is given.)

Electro-Deposition of Brass.—In an article by Mr. Sutton in "Elec. Power" for August he gives the results of a number of experiments and discusses the subject from a theoretical point of view. He shows that the impressed voltage must be kept low, the best results being obtained when it is just a little higher than the counter E. M. F. of the solution, which means that the current density must be kept low; in all the experiments the deposit started at the bottom of the cathode and gradually worked toward the top; as the voltage is increased the copper is taken out first and if greatly increased there is nothing left on the surface of the anode but zinc; as the E. M. F. is increased there is an increase of the zinc deposit; the best solution is the one that has the lowest E. M. F. He gives the results obtained with a number of different solutions and shows among other things that the results will be better the purer the solution. He comes to the following conclusions: The alloy deposited depends on the impressed E. M. F.; as the latter is increased the alloy will change its proportions, which depends on the velocity of migrations of the ions in the different salts; as the impressed E. M. F. is increased the counter E. M. F. will increase, but at greatly reduced rate.

Electrolytic Laboratory at Stolberg, Germany.—A brief description of the laboratory of the Stolberg Company for the extraction and metallurgy of zinc and lead, is given in the "West. Elec.," Aug. 17, the chief interesting feature of which is the arrangement of the circuits and switchboards, which is illustrated. The apparatus consists of a 12-volt, 60-ampere dynamo and two accumulator batteries of three cells each, which may be variously combined, the connections being all made at the switchboard.

Welding Lead.—According to the "Eng. & Min. Jour.," Aug. 10, Mr. Blondel of France has devised the following ingenuous method: the surfaces are carefully cleaned and a thin layer of lead amalgam is placed between them; on passing an ordinary soldering iron along the junction the mercury is vaporized, the lead, set free in an exceedingly finely divided state, unites the two surfaces together.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Errors in Photometric Standards.—The Lond. "Proc. Phys. Soc." for July abstracts a paper by Mr. Liebenthal from the "Zeit. f. Instrumk.," 15, p. 157. The intensity of light from standards is influenced by the atmospheric conditions; he determined these effects, on behalf of the Reichsanstalt, and gives the results. For the Hefner amyl acetate lamp his results are as follows: if y is the correct luminosity then

$$y = 1.049 - 0.0055\,x,$$

in which x represents the number of litres of water vapor present in one cb. m of the surrounding air; by applying this correction the luminosity is correct within 1 per cent. and probably 0.4 per cent., as regards humidity. During the Winter months the intensity was 3.5 per cent. greater than in the Summer months; if the intensity is taken as unity during March, April, May, October and November the results from June to September are about 2 per cent. too small and for December, January and February about as much too great. If ay is the variation of light intensity corresponding to b millimetres of mercury then

$$ay = 0.00011\,(b - 760)$$

which means that a change of 40 millimetres brightens or dims the flame by 0.4 per cent. If x is the number of litres of carbonic acid gas per cb. m of dry air then

$$y = 1.012 - 0.0072\,x$$

that is, one litre more or less per cb. m produces a change of about 0.7 per cent. The second part of the paper refers to the pentane lamp; considerable time is required for this lamp to settle down to working conditions; the metal tubes supplying the hot air do not assume a constant temperature at once; the corrections on account of atmospheric changes are all greater in this than in the Hefner lamp; the correction for humidity is

$$y = 1.232 - 0.0068\,x$$

or, an amount equal to one litre per cb. m causes a change of 0.6 per cent.; the barometric correction is

$$ay = 0.00049\,(b - 760)$$

thus a change of 40 mm of mercury produces a variation of 2 per cent. From a comparison of these results the Reichanstalt has decided to give preference to the Hefner lamp. (No mention seems to be made of the effect of the temperature of the surrounding air, which, according to experiments made by the compiler with a standard candle, was so great

that in a cold room it was found impossible to make the candle burn normally.)

Shipboard Galvanometers.—Mr. Rymer-Jones in a communication to the Lond. "Elec.," July 26, gives the results of some comparative tests made with the Sullivan galvanometer (see Digest, April 13), and the Thomson marine galvanometer, provided with the damping device of Messrs. Weatherall and Clark, which is described and illustrated in the Lond. "Elec.," July 26. The resistance of the coil of the Sullivan galvanometer was 600 ohms, and that of the other 7,000; the results show that with the former the deflections were directly proportional to the current, and there was no creeping, while with the latter there was considerable creeping; the former was about twice as sensitive, and in the latter the zero is displaced as the ship's course is altered and considerable trouble is likely to arise with the suspension; for speaking purposes both instruments are sufficiently dead beat, although the former gives more distinct signals; with the Sullivan instrument the throws are practically proportional to the capacities of the condensers discharged through it, and the results are decidedly better than in the other; he concludes that the Sullivan instrument is decidedly the better.

In issue of Aug. 2 Mr. Sullivan states that on shipboard the suspended wires must be sufficiently strong and rigid to prevent the sagging of the coil as the vessel rolls and pitches; for measurements on shore the sensitiveness can be increased five-fold by suspending the coil more delicately and as much as ten-fold by letting it swing freely, the current being let off below by a fine wire spiral; except for very delicate laboratory operations the ordinary plan of a top and bottom suspension is preferable.

Influence of Electrically Dissolved Gas of Deposited Silver.—The Lond. "Elec. Rev.," July 26, abstracts briefly from the last number of the "Weid. Ann." a paper by Mr. Myers. He finds that if the same current is sent through two voltameters containing neutral solutions of silver nitrate of the same strength and at the same temperature, one being in a vacuum and the other in air, then the weight of silver in the former is about 0.1 per cent. greater than in the latter when the solution contains 20 to 40 per cent. of silver nitrate; for a 5 per cent. solution the difference is somewhat smaller; when the solution is saturated with carbon dioxide the deposit is about 0.055 per cent. lighter than when saturated with air, while with nitrogen the deposit is about 0.05 per cent. heavier than with air. With a current of more than 0.25 amperes (per sq. decimeter?) an evolution of gas takes place at the anode in the vacuum. He finds that the gray deposit which is formed on the anode consists of pure silver oxide.

Influence Machines.—In the Lond. "Elec.," July 26, Mr. Taylor criticises the articles which were abstracted in the Digest, Aug. 10. He does not see in what respect Mr. Schaffers has succeeded in improving the Wimshurst machine as there is little that is novel in his final form, it being simply a somewhat distorted Wimshurst machine and contains some very doubtful improvements; the Wimshurst machine is essentially a high tension machine but the method of testing used by Mr. Schaffers keeps the machine working at a comparatively low tension. He describes some modifications which he published some years ago. He believes the machine usually described as Holtz No. 2 is far behind those of the Wimshurst type from all points of view.

Magnetic Units.—The paper by Prof. Lodge, an abstract of which was published in THE ELECTRICAL WORLD, Aug. 3, p. 135, is published in full in the Lond. "Elec.," Aug. 2.

New Method of Measuring Electric Capacities.—A translation of the complete paper of Mr. Bordier, which was abstracted in the Digest last week is published in the Lond. "Elec. Eng.," July 26.

Storage Batteries in Telegraph Work.—The systems used in several different installations are illustrated and briefly described in "Elec. Eng.," Aug. 14, and their advantages over the usual primary batteries are shown.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephony in Japan.—"L'Ind. Elec.," July 25, gives the following statistics taken from official reports, for the year 1893 to 1894: Tokio 6 stations, Yokohama 2, Orsaka 3, Kobe 2, total 24, serving respectively 1,689, 367, 415 and 201 subscribers. The telephone was introduced in Japan in 1877, when it was used in the police service; in 1890 public stations were introduced; the length of the lines during the year above referred to is 650 km and the length of the wire 609 km including the lines from Tokio to Yokohama and Orsaka to Kobe; the cost of operation during that year was 270,000 francs while the receipts were 486,000 francs; the mean cost per subscriber was 102.25 francs after deducting the cost of the installation; the mean receipts per subscriber were 179 francs; similar statistics for the preceding years are also given.

Telephony in the United Kingdom.—According to the Lond. "Elec." Aug. 2, nearly $750,000 have been spent on exchange extensions in the United Kingdom within the last six months and over 4,000 new lines have been erected; by the close of the year the whole of London will be metallic-circuited.

High-Speed Cable Signaling.—Mr. Delany in the Lond. "Elec.," Aug. 2, states that the speeds published in that journal almost a year ago, which were attained by using his system, were not correct owing to erroneous assumptions; the corrected speeds are as follows: with the 1873 and 1874 cables, 153 letters per minute; with the 1880, 133, and with the 1894, 251; a facsimile is given of a message sent at the last named speed.

Siphon Recorder.—The improved Muirhead instrument is described and well illustrated in the Lond. "Elec.," Aug. 2; the most novel feature lies in the suspension piece in which the suspended coil is connected by means of two fibres attached at one end to a light arm fixed on the coil and at the other end to the aluminum cradle to which the siphon is cemented; one fibre is fastened to the aluminum cradle above the stretched wire which carries it and the other fibre is secured to a part of the cradle below each wire.

MISCELLANEOUS.

International Catalogue of Scientific Papers.—A brief summary of the recommendations in the report of a Royal Society committee, are given in the Lond. "Elec.," July 26; the report is published in full in "Nature," July 18. The committee has been at work for over a year; a circular letter was addressed to 207 societies and institutions to which more than 100 replies were received; in no case was any doubt expressed as to the extreme value of the work contemplated and only two or three questioned the possibility of carrying out the work; the importance of having complete subject catalogues and not mere transcripts of titles was generally recognized; some replies, especially from the United States, urged that steps should be taken at once to put the scheme into action; no definite information as to the best method of putting the scheme into operation could be gathered from the replies and no estimates of cost were given. The opinion was expressed repeatedly that English should be the language; some form of card catalogue was generally favored; it was urged that an international congress should be held to discuss the plans and it was requested to call such a congress for July, 1896. Editorially the view is expressed that the only factor essential to the success of this undertaking is that the work shall be done by men who have actually read and digested the papers and that it shall not be relegated to index markers; "an index compiled by an army of human machines can serve no useful purpose. The outside co-operation of experts can alone ensure success."

Amalgams.—In a Physical Society paper by Mr. Gouy, abstracted in "L'Eclairage Elec.," July 27, he gives the results of carefully made measurements to determine the amounts of different metals which are taken up by mercury in forming amalgams; the figures are given as follows for the ratio of the weight of metal dissolved to the total weight: Iron 0, copper 0.00001, silver 0.0003, gold 0.0013, tin 0.006, bismuth 0.012, lead 0.013, zinc 0.018, cadmium 0.040, Darcet alloy (not described) 0.38; in these determinations great care was taken to have no excess of unamalgamated mercury.

Importation of Dynamos into Japan During 1894.—According to the "Elek. Zeit.," July 25, the value of dynamos exported from Germany to Japan in 1892 was 73,741 yen, which far exceeded that from Great Britain or the United States; in 1894, however, those imported from Germany amounted to 18,120 yen, from England 49,222 yen and those from the United States 145,200 yen.

Cataphoresis and Solutions of $H_2 O_2$ for Bleaching Teeth.—The Lond. "Elec. Rev.," July 26, reprints from the Philadelphia "Dental Cosmos," a recent paper by Dr. Morton.

Researches with the Discharges from an Electric Fish.—An Academy paper by Dr. d'Arsonval describing his recent researches with discharges from the "Torpille" (an electric fish, presumably the one called the torpedo or electricray) is published apparently in full in "L'Ind. Elec.," July 25. He passed the discharges from the fish through measuring and recording instruments thereby obtaining the curves representing the discharge. He states that the muscle and the electric organ obey the same general laws and that the electric and the muscular action explain each other; the muscular contraction and the discharge of the electric organ he believes are due to the same cause; the electric discharge of the organ is only an exaggeration of the electric oscillation which takes place in muscles when they contract.

Commercial Product Resulting from Acetylene.—Mr. Duncan, in "Elec. Eng.," Aug. 14, describes briefly how acetylene produced cheaply, by means of the electric furnace, may be used in combination with such cheap commercial products as hydrochloric and sulphuric acids, potash, ammonia and a few other, to build up a whole system of dyes, medicines, essences, perfumes, poisons and explosives.

Electrical Engineering Education.—In "Elec. Power" for August, Prof. Anthony discusses the subject in a general way and gives a description of the course at Cornell University, which is accompanied by illustrations of the various laboratories.

American Electrical Works Annual Clam Bake.

A party of nearly 200 jolly and jubilant representatives of the electrical industry accepted the cordial invitation of the American Electrical Works and celebrated the 17th annual clam bake, by far and away the most pleasant of these enjoyable reunions, and the 25th anniversary of the founding of the American Electrical Works, at Haute Rieve, Providence, on Saturday, Aug. 17. Mr. Eugene Phillips, the genial and popular founder, president and host, it was felt by his colleagues in the firm, was entitled to receive special recognition on so auspicious an occasion. As in former years invitations were sent to all parts of the United States and Canada, and guests were present from almost everywhere. Boston and New York, of course, contributed a great many

representatives, while Canada was also largely in evidence. The handsome quarters of the Union Club at Haute Rieve, overlooking the Providence River, was the rendezvous. Special electric cars had thoughtfully been chartered for the trip which is some four miles long.

On reaching the grounds each visitor registered and was decorated with the official badge, consisting of an oxidized silver gilt disc, somewhat smaller than a soup plate, which bore the inscription: "1870. American Electrical Works. 25th Anniversary and 15th Annual Clam Bake. Aug. 17, 1895." The disc was suspended by a blue ribbon, and secured to the breast of the wearer by means of a silver pin.

A fine orchestra discoursed popular music, and, after the first ebullition of animal spirits, the guests organized baseball teams and played a spirited game or two, the result being six to six for the Boston and New York teams.

It is needless to say that the bake was a typical Rhode Island spread, complete in every detail, with an abundant supply of steaming hot clam water added for the refreshment of those who happened to feel the effects of the passing years. During the repast souvenirs were distributed to all. These reminders of the jolly day consisted of a small circular basket filled with clams and ears of corn, the whole wrought in silver, the handle of the basket bearing an appropriate inscription.

When cigars had been reached, the genial host rapped for order, and having cordially welcomed all present, made a feeling allusion to those who, in years past, had been present on these occasions, but who had since joined the great majority. Referring then to the absence of many old friends who were unavoidably prevented from being present, he stated that many pleasant letters had been received.

Mr. Thos. D. Lockwood, of Boston, then accepted the office of toastmaster, and called upon Mr. Ralph W. Pope, of New York, to respond to the toast, "Telegraphy." In a very felicitous manner Mr. Pope spoke of the ups and downs, the ins and outs of a telegraph operator's life and work. At the close of Mr. Pope's address, Mr. J. D. Lockwood was asked by Mr. Phillips to respond to "The Telephone," which he did in his usual entertaining manner.

"The Electrical Press" was responded to by Mr. W. S. Key, of Boston, who delivered an admirable speech, which he closed with a glowing tribute to Mr. Phillips and the American Electrical Works. "The Electrical Transmission of Power" was responded to by Mr. C. S. Sergant, general manager of the West End Railway, Boston. Capt. Brophy next spoke in response to the toast of the "Electric Light." As a pioneer whose experience had been both long and varied, Capt. Brophy had many interesting things to speak about.

In response to a demand for a few words from the host Mr. Phillips briefly recounted the story of his early labors in the field of electric wires and cables.

Mr. E. R. Phillips, Jr., also acknowledged a compliment paid him, after which the fun was resumed until the hour for departure arrived, when there was the usual handshaking and kindly good-byes, as the 17th annual clam bake became a thing of the past.

Non-Condensing Compound Engines on Variable Loads.

Referring to Mr. Richart's article on the "Selection of High-Speed Engines for Electric Lighting," which was published in our issue of Aug. 10, The Phœnix Iron Works Company, of Meadville, Pa., writes that its engineers dissent from Mr. Richart's conclusion that where the load varies much and is light much of the time it will not pay to compound unless fuel is high, and that the engine should always be run condensing as well; they claim that they have succeeded in demonstrating with a high-speed compound engine that it does pay to run non-condensing on variable loads, even in cases where fuel is not high. They also state that it is not possible on their compound non-condensing engine to get any condition of load so light whereby the low-pressure cylinder becomes a drag, instead of doing its share of work, and, furthermore, that the variation in the intermediate or receiver pressure is a very small fraction of that found on engines where the valve of the low-pressure cylinder is driven by a fixed eccentric. The company claims that in the "Dick & Church" compound engine for electrical work, results have been obtained which refute the arguments that are made against the single-valve type of engine in favor of either the two-valve or four-valve engine, and states that it has been demonstrated that it is necessary to handle both valves with the governor to ensure a close degree of regulation, as well as to avoid a wide variation of cylinder temperatures, and in the cross-compound engine to obviate an excess of initial thrusts on one side of the engine. The Phœnix Company admits, however, that the best results in any case are to be obtained where the engine is run condensing.

Electricity in Mining.

The successful operation, in the "Pittsburg vein," of electrical coal mining machinery is of very recent date. Attempts were made to mine this coal with machines of the cutter-bar type, but owing to the presence of "sulphur bands" they failed to do satisfactory work. These "sulphur bands" consist of layers of iron pyrites, which are extremely hard, and they proved an effectual obstruction to the machines. In the Hocking Valley region, on the other hand, the coal yielded readily to machines, and since the product from both of these fields depends for its market, in a large measure, upon lake trade, the operators of the Pittsburg district found themselves at a serious disadvantage in being forced to compete with the machine-mined coal from the Hocking Valley.

The chain type of breast machine has proved itself capable of cutting the Pittsburg coal, and to it the operators of these mines are looking for a solution of their difficulties. The first extensive machine plant in this field using electric chain machines has just been put in operation at the Nos. 2 and 3 mines of the Essen Coal Company, located about 12 miles from Pittsburg, on the Pittsburg, Chartiers & Youghiogheny Railway. It was installed by the Link-Belt Machinery Company, of Chicago, and is by far the largest plant of its kind in the world. The coal is both cut and hauled by electric machinery.

These mines are situated on what is locally known as "Tom's Run," a most picturesque valley, flanked by hills from one to two hundred feet high, which are underlaid with bituminous coal. The coal crops out of the hillside a few feet above the track of the railway which runs through the valley, and the mines are, therefore, drift mines opened by tunnels. The main tunnels of the two mines are seventeen hundred feet apart.

The "Pittsburg vein" is a bituminous and almost a block coal, breaking off, when blasted, almost perpendicular and square across the room. The working seam, which averages five and a half feet thick, rests on a bed of limestone; the machines work in the coal just above the limestone floor making a cut four inches high and going five feet under. The drilling is then done about five feet from the floor and the blasting brings out the lower seam of coal and the foot of slate directly above it.

The power house from which the mining machines are operated is situated 200 feet from the mouth of the No. 3 mine and fifteen hundred from that of No. 2, and is 130 feet long by 56 feet wide. One end is occupied by the boilers, feed-water pumps and feed-water heater; in the centre is the engine and dynamo room, and at the other end is a machine shop, blacksmith shop and locomotive room. There are four boilers, each 72 inches in diameter by 18 feet long and containing 64 4-inch lap-welded tubes. The water is taken from two artesian wells, drilled in the boiler room for that purpose. There are three single-expansion Corliss-type engines, each capable of delivering 250 hp at 150 revolutions, with steam at 100 pounds pressure. Each engine is belted to a 150-kw "Independent" mining type dynamo. These are inverted horseshoe bipolar machines of especially substantial design, and are well adapted to stand the severe strains and heavy overloads to which mining work subjects them. They are fitted with self-oiling, self-aligning journals, ventilated armatures and clamped carbon brushes. Dynamos of this type have, during the past four years, won for themselves an enviable reputation in the coal-mining plants of Ohio, Indiana, Illinois, Kentucky, Missouri and Kansas.

The generators are connected to the switchboard by 400,000-circ. mils flexible cables leading overhead. The switchboard is of white Italian marble, in three panels, fitted with Weston instruments and the usual complement of switches and very handsomely finished.

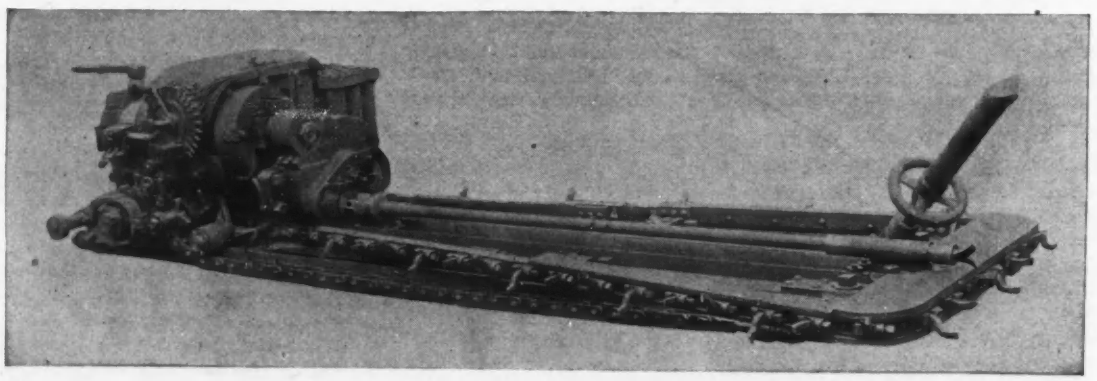


FIG. 1.—CHAIN TYPE ELECTRIC COAL CUTTER.

The coal is undermined by sixteen "independent" electric chain breast machines, one of which is shown in Fig. 1. These machines consist primarily of two parts; the lower frame, which is jacked down solidly to the floor, and the upper frame which slides on it. This upper frame carries a 20-hp motor, which through double reduction gearing runs a special form of steel sprocket chain, which carries the tools for the cutting. The motor also runs a feed sprocket which engages with a feed chain on the stationary frame, whereby the movable frame is fed ahead. A single lever enables the operator to feed ahead, to back out, or to stop altogether, as he finds necessary. The machine makes a cut three and a half feet wide, four inches high and five feet deep, and under ordinary

conditions will make from 30 to 40 such cuts in a shift of nine hours, although as high as 46 cuts have been made by one machine in nine hours. As the coal vein is five and a half feet thick, this represents 150 tons of coal for the work of two men.

The hauling is done by two "Independent" 80-hp electric mine locomotives. These are four-wheel, single-motor machines, and run at eight miles an hour, pulling trains of from 30 to 40 loaded bank cars. They weigh 10 tons each and are built in accordance with the best engineering principles. The drivers are provided with soft steel tires shrunk on and riveted, and since all four of them are geared to one armature shaft, they are compelled to revolve at identically the same speed, thus further increasing the tractive effect. Notwithstanding the fact that both axles are geared to the single armature shaft, they are free to take various positions with reference to one another, owing to track irregularities, without throwing the gears out of alignment. The entire mechanism is confined to the space between the drivers, as the illustration clearly shows (see Fig. 2); this is a valuable feature in mine work where

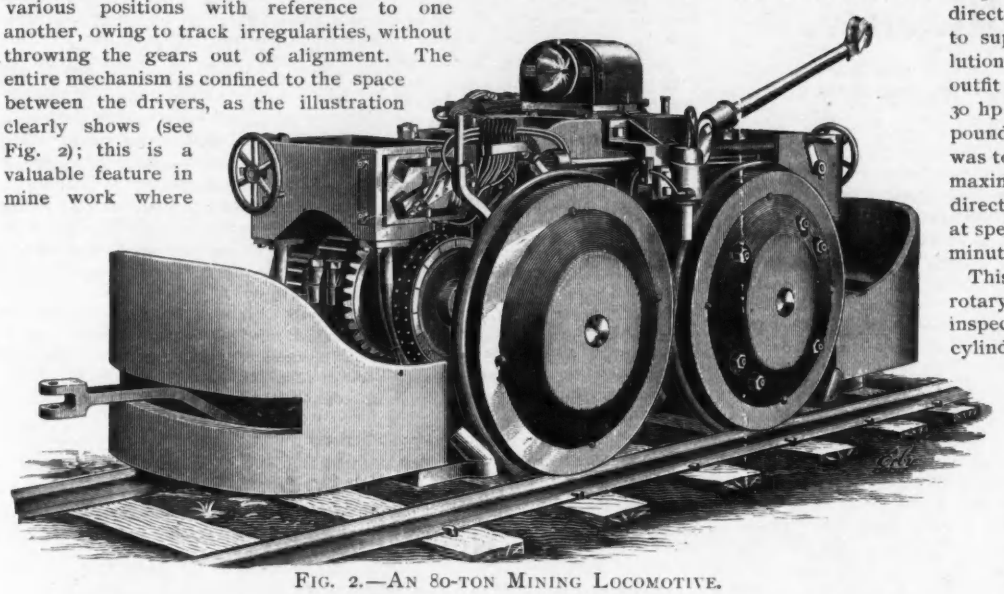


FIG. 2.—AN 80-TON MINING LOCOMOTIVE.

the passages are narrow and space outside of the rails is not to be depended upon. Each locomotive is provided with an arc lamp headlight. A special form of small arc lamp, passing three amperes, is mounted with the arc at the focus of a parabolic reflector. With this bright light it is possible for the motorman to run at a much higher speed than would be possible under different circumstances. Fig. 3 shows one of these

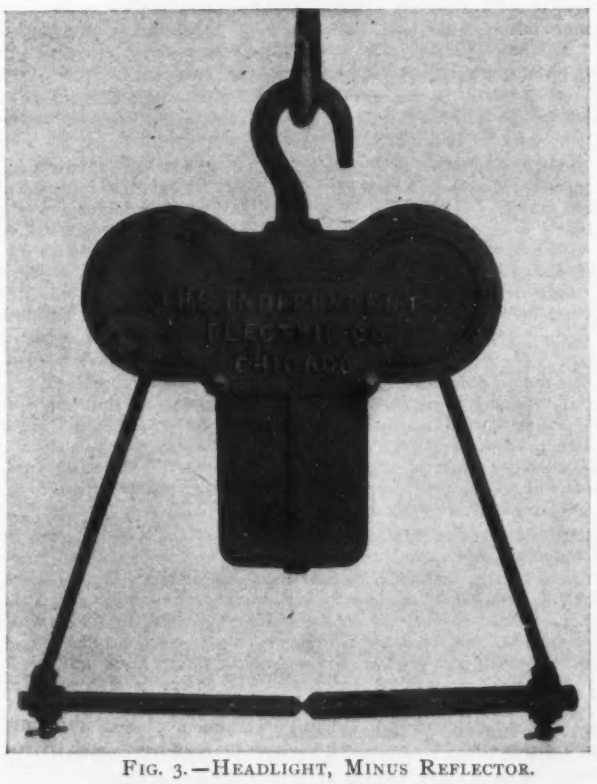


FIG. 3.—HEADLIGHT, MINUS REFLECTOR.

lamps without the reflector. The locomotives bring the coal from points in the mine to the foot of the slope, which is about 200 feet underground. From here the coal is taken up the slope to the tipple in trips of four or five cars by a rope.

This plant has a capacity of 2,400 tons of coal per day. The cutting machines are run double shift, but the hauling is done only during the day, each locomotive being capable of hauling 1,200 tons of coal in nine hours.

The entire output of the mines is controlled by Pickands, Mather & Co., of Cleveland, O., who are very extensive lake shippers, and it is shipped by them from Ashtabula to Duluth and other northern lake ports. It has been the policy of this business house to adopt labor-saving machinery whenever an opportunity has presented itself, and the mines under their control were equipped with electrical machinery in order that they might produce and handle coal with the greatest efficiency possible.

A New High-Speed Engine.

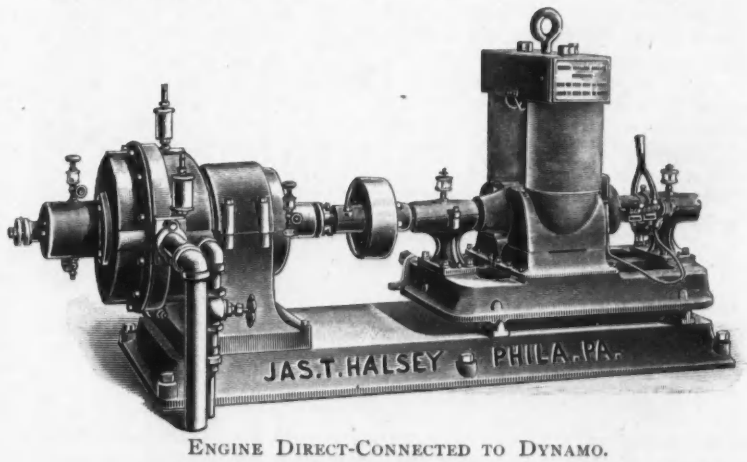
We illustrate below a novel high-speed steam engine, or motor, which is being put on the market by James T. Halsey, Twenty-sixth and Callowhill Streets, Philadelphia. The cut shows one of the engines direct-connected to an Edison dynamo designed to supply 300 lamps at a speed of 1,400 revolutions per minute. The steam motor for this outfit was furnished under a guarantee to develop 30 hp with a mean effective steam pressure of 40 pounds, at the speed above mentioned; the speed was to vary less than 2 per cent. from minimum to maximum load. These engines are also made for direct-connection to rotary blower fans running at speeds ranging from 2,000 to 3,000 revolutions per minute.

This machine does not belong to the class of rotary engines, as might be supposed from a casual inspection of the illustrations; it is of the multi-cylinder type, having four cylinders to each crank. There are no connecting rods or cross-heads, and only two moving parts to each crank. The reciprocating parts are balanced by using two cranks set 180 degrees apart.

This form of design allows the use of a very large crank pin and main bearing surfaces, on which there is a light pressure per square inch. The lubrication is effected by submerging the bearings in oil and a stuffing box is provided on the end of the bearing to prevent its escape. The governor, also, in the automatic engine, is entirely encased in a chamber which is filled with oil.

One of the best features claimed for the engine is that it requires no attention whatever, except to keep the oil chambers filled, in which the moving parts are entirely encased, free from dust and of course well lubricated. What few joints there are are balanced and under a light compression, so that wear is almost eliminated and practically no adjustments are required. It is stated that one of these engines has been running continuously night and day for about ten months under very trying conditions. The steam is wet, being brought some 800 feet through an exposed pipe, and the exhaust is subject to a back pressure of several pounds, notwithstanding which drawbacks the results are reported as being eminently satisfactory. This engine supplanted an automatic high-speed engine of a well-known make which ran five weeks and was, of course, belted to the load instead of being coupled direct, as is the case of the Halsey engine in question.

With regard to economy, it is claimed that the results are all that can be desired, the engine being capable of any proportion of compounding up to quadruple expansion, without adding any additional parts, the valve gear being controlled by an automatic governor, so as to adjust the expansion to the load.



ENGINE DIRECT-CONNECTED TO DYNAMO.

From the nature of the design of this engine, and its light weight per horse-power developed, the builders are able to guarantee it in every particular, especially as to the wearing qualities, and they also offer the novel proposition to purchasers to renew the entire motor when repairs are necessary, charging them with the repairs to the old engine, which in most of the cases has been found insignificant, generally covering only the replacing of the bronze bushings.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Aug. 17, 1895.

AMERICAN BELL displayed still more strength this week, hovering in the neighborhood of 200, which point it touched several times. The stock has shown decided bullish tendencies throughout the past three weeks, but its rise has been slow and characterized by an element of uncertainty, which served as a damper upon the enthusiasm of outside advocates.

EDISON ILLUMINATING, of Brooklyn, reports for July net earnings of $20,633 against $9,797 last year. Deducting taxes and interest on bonds, there remains applicable for dividends $11,891, as compared with $5,514 last year. This includes, of course, the operation of the Citizens' plant, which was absorbed in May of this year.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	120	125
Edison Electric Ill., New York	100	97	100
" " " Brooklyn	100	110	115
" " " Boston	100	150	..
" " " Philadelphia	100	..	115
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	44¾	45
General Electric	100	36⅝	36¾
General Electric, pref	100	69	71
Westinghouse Consolidated, com	50	36	37
" " pref	50	53	54

BONDS.

Edison Electric Ill., New York	105	105½	105½
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	..	90¼

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	..	200
American District Telegraph	100	30	40
American Telegraph & Cable	100	95½	..
Central & South American Telegraph	100	117	120
Commercial Cables	100	150	..
†Erie Telephone	100	57	57¼
Gold & Stock Telegraph	100	105	..
New England Telephone	100	88	90
New York & New Jersey Telephone	100	103	105
Postal Telegraph-Cable	100	63½	..
Western Union Telegraph	100	93½	93¾

ELECTRIC TRACTION STOCKS.

Baltimore Traction	25	20	20¼
Binghamton RR. com	100	100	..
Brooklyn Traction	100	15	18½
" " pref	100	..	53
Buffalo St. Ry	100	88	91
Cleveland City Ry	100	69	70
Cleveland Electric Ry	100	59	60
Columbus St. Ry	100	48½	..
Consolidated Traction of N. J	..	25	27
Electric Traction, Philadelphia	50	73	74
Hestonville	100	58	58½
Long Island Traction, 1st in pd	100	15½	16
Louisville St. Ry. com	100	37	39
" " " pref	100	87	88
New Orleans Traction	100	24	27
" " pref	100	79	81
North Shore Traction	100	34½	36
" " pref	100	84	88
People's Traction $30 pd	25	66⅛	66⅜
Philadelphia Traction	50	84½	84¾
Rochester St. Ry	..	38	..
Union Ry. (Huckleberry)	100	112	115
West End, Boston	100	75	75½
" " pref	100	92	92½
Worcester Traction	100	18	20
" " pref	100	86	90

BONDS.

Buffalo St. Ry. 1st con. 5s	100	106	109
*Binghamton Railway Co. 5s	100	99	100
*Columbus St. Ry. 1st 5s	100	104	..
Rochester St. Ry. 1st 5s	100	95	97
*Union Ry. 1st mtge 6s	100	105	108
*Westchester Electric 1st mtge 5s	100	98	101

* With accrued interest.
† Ex-Div.

GENERAL ELECTRIC does not fluctuate a great deal. It is stated that the original negotiations between General Electric and Westinghouse were never entirely broken off, and that both parties are understood to be closer to an agreement on these lines than they have been at any time. On the other hand, Mr. Westinghouse is credited with entertaining views which conflict with the above statement. The General Electric people are reported as claiming that they are in position to establish relations between their company and the Baldwin works, identical with those recently perfected by the Westinghouse Company, but the report is not particularly authentic, nor does it appear just what benefit could accrue to the General Electric interests from such claim.

UNION TRACTION A SUCCESS.—Despite the fact that not a few have been doubtful as to the ability of the new Union Traction Company at Philadelphia to prove a satisfactory money earner, so far as payment of good dividends on its stock is concerned, there seems to be no doubt that stockholders of the People's and Electric Traction companies are more or less unanimously in favor of the consolidation of these systems with the Philadelphia Traction Company. Announcement is made that all that is now needed to complete the plan is the approval of it by the stockholders of the Philadelphia Traction Company; and this they are expected to do in due course. A comment on the deal is the ease with which a transaction of its magnitude is being carried out. It has been only a short time since holders of the various stocks concerned were invited to signify their assent or dissent. Notwithstanding the fact that a good many stockholders of the various companies are out of town, the number of shares assented show the favor with which they regard the plan. Up to the close on Wednesday, of the 175,000 shares of Electric Traction stock, holders of over 125,000 shares had assented, and out of 200,000 shares of People's Traction 140,000 had thus far signified their approval of the plan. It may be set down again, therefore, that the plan of consolidation is a success, largely owing, however, to the confidence of the local investment community in John Lowber Welsh, who is to be the head of the Union Traction Company.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Aug. 19, 1895.

MR. H. G. OSBURN, of the Osburn Electric Company, of Chicago, was in New York this week.

J. GRANT HIGH & CO., of Philadelphia, have established an office in the Electrical Exchange Building, 136 Liberty Street.

A BRANCH OFFICE has been opened at 66 Broadway, by the Electric Storage Battery Company, of Philadelphia, manufacturers of "Chloride" accumulators.

FIRM DISSOLVED.—The firm of Doubleday, Mitchell & Co. Thames Building, has been dissolved. Mr. Chas. D. Doubleday will continue the business under his own name, and assumes all liabilities and contracts of the old firm.

INJUNCTION REFUSED.—The application of a number of residents of Staten Island for a permanent injunction, restraining the Staten Island Electric Company from laying its tracks in front of petitioners' property, was denied last week by Judge Gaynor of the Supreme Court.

ELECTRIC LIGHTING AT GREENPORT.—At a special meeting of the stockholders of the Greenport (L. I.) Electric Light & Power Company held last week it was voted to sell the entire plant, giving Greenport parties a refusal for a few days. The company appointed a committee to negotiate for the sale of the property. If Greenport parties do not decide to buy it within a month an effort will be made to sell out to outside parties, and unless the property is sold within 30 days the plant will be shut down and Greenport will then have taken a step backward. The company has been running behind for some time.

BOARD OF ELECTRICAL CONTROL.—At a meeting last week of the Board of Electrical Control the secretary reported that since January last there had been removed 609 poles and 1,146 miles of wire. Commissioner Kearney said some of the companies were asking for more mains on Sixth Avenue, alleging that the present ones were inadequate. He also said that there were several unused ducts on the avenue, but that the companies refuse to enter them, saying they were not built properly. The matter was referred to a committee. The new commissioner, Thomas L. Hamilton, was present for the first time in his official capacity.

TELEPHONE EXTENSIONS ON LONG ISLAND.—The New York & New Jersey Telephone Company has reached Greenport with its lines. A single gang of linemen put up four No. 9 copper wires from Riverhead to Greenport, a distance of 21 miles, in five days. The company will have its central office at Greenport, corner Main and Front Streets. There will be two metallic circuits from Greenport to Quogue as soon as the line is completed between Riverhead and Quogue, and at Quogue connections will be made for the long-distance service when requested. The company proposes to have the line in operation between Greenport and New York by the 20th of the month. The line will be continued on to Orient Point, nine miles east of Greenport.

THE WAR between the Nassau Electric Railway and the Canarsie & Rockaway Beach road for Canarsie and Rockaway Beach patronage becomes hotter as the Summer progresses. What with the building of fences at Canarsie to shut out the patrons of the rival road and the running of rival excursion boats to Rockaway Beach, the excursionists on either road have a lively time of it, and it is now reported that the Nassau Electric Company has an option on a mile of water front at Canarsie, and will make extensive improvements there in the way of not only dock facilities, but hotel and boathouse accommodations.

THE LONG ISLAND BICYCLE RAILWAY PROJECT.—The annual meeting of the Kings, Queens & Suffolk Bicycle Railway Company, which

proposes to construct an electric bicycle railway to Far Rockaway, L. I., was held last week. President F. W. Dunton made the statement that $230,000 of the stock of the road had been subscribed, mostly in Long Island, there being 2,000 subscribers to the stock, in amounts ranging from $25 to $1,000. Mr. Dunton stated that of this amount $62,500 had been called for and paid in, of which $5,500 had been used in expenses, the balance being in the bank. He added that with $150,000 in hand it would be safe to make a start in the work of construction, and if the whole amount of the stock was paid in it would be sufficient to build the entire first section from the terminus of the Kings County Elevated Railway to Far Rockaway.

GENETT AIR BRAKE COMPANY.—Judge O'Brien, in New York City, has refused the application of Charles Putzel for an order directing the secretary of the Genett Air Brake Company to show cause why he should not exhibit to the former the books of the company. Mr. Putzel is a lawyer, and owns 200 shares of the stock. The company was organized in Illinois, but has offices in this city. Mr. Putzel declares that since Jan. 18, 1893, the directors have met in the offices of J. & W. Seligman, in New York, and that on July 24 last Mr. Straus refused to show him the books. Mr. Putzel declared that the Seligmans have applied for a receiver in Chicago, alleging that they are judgment creditors for $75,000, which, he says, was improperly obtained. He declared that the Seligmans desire to acquire the Genett Air Brake Company's property for the Standard Air Brake Company. James Seligman submitted an affidavit declaring that his judgment against the Genett Company for $75,191 was properly obtained, and that the Standard Air Brake Company is now in active operation, and has no need of the Genett Company.

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 120 Atlantic Ave.,
BOSTON, MASS., Aug. 17, 1895.

MR. J. F. BUBERT, electrical engineer and contractor, is now snugly located in his new quarters in the Stock Exchange Building, 53 State Street, Boston. Through energy and perseverance Mr. Bubert has built up a nice construction business, all of which he richly deserves.

HEATERS FOR WEST END CARS.—The West End Street Railway Company has contracted to have heaters placed in 750 box cars. As more than a hundred of the company's cars were supplied with heaters last Winter, when the new order has been filled practically the whole road will be equipped with electrically heated cars, for of the 1,800 cars operated by the West End Company only about 900 are for Winter use.

BOSTON, MASS.—The cars of the Lynn & Boston Railway have commenced running over the new elevated bridge between Chelsea and Charlestown. The first car was in charge of General Manager E. C. Foster as motorman and Assistant Superintendent John M. Curley conductor. The car contained as guests of the road Representative F. O. Barnes, ex-Representative M. M. Merritt, Oliver Clark, superintendent of Mystic Wharf; Gilbert Hodges, engineer Long Branch Railway; Purchasing Agent Henry Grover and W. B. Woodward, superintendent of repairs of the Lynn & Boston Railway.

HON. HUGH O'BRIEN, ex-mayor of Boston, whose sudden death occurred a few days ago, will be remembered particularly by the electrical fraternity generally, because of the meeting of the National Electric Light Association in Boston in 1888 during his term of office. This meeting was one of the largest and most notable gatherings of this association and all will recall his kindly welcome and hospitality. Mr. O'Brien was treasurer of the Brush Electric Company, of Boston, from 1881 to 1887, and, when it was incorporated into the Boston Electric Light Company, became its vice-president, a position he held creditably and honorably up to the time of his death.

THE THOMPSON-BROWN ELECTRIC COMPANY, of Boston, did itself proud on Tuesday, Aug. 6, through its "First Annual Outing" to its friends and patrons. A special steamer had been chartered for the occasion and upward of 100 prominent electrical celebrities of New England enjoyed a delightful sail along the North Shore via "Boston Light" to Marblehead and return, indulging to their hearts' content in deep sea fishing, sport and all the pleasures incident to such an occasion. A most tempting dinner was provided on board the steamer, and the day was greatly enlivened throughout by choice music from an excellent band and orchestra specially engaged. The general verdict was that it was a grand treat and the happiest kind of favors of reciprocity and remembrance for the business recognition it is so liberally receiving.

WESTERN NOTES.

Branch Office of THE ELECTRICAL WORLD,
936 Monadnock Building,
CHICAGO, Ill., Aug. 17, 1895.

PIERCE & RICHARDSON, 1409 Manhattan Building, Chicago, who, for the past year, have so successfully looked after the Western interests of the Electric Storage Battery Company, have decided to devote themselves entirely to engineering work. They will, however, act as consulting engineers to the new office of this company, recently opened in Chicago.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, of Kokomo, Ind., reports having secured the following new contracts: Crane, Wis., 500 telephones; Shreveport, La., 400 telephones; Mineva, La., 125 telephones; New Castle, Pa., 300 telephones; Logansport, Ind., 200 telephones; Defiance, Ohio, 200 telephones. Besides these 20 contracts were recently closed for exchange of from 50 to 100 subscribers.

MR. E. M. BARTON, president of the Western Electric Company, recently met with a serious accident near his Summer home at Hinsdale, Chicago. While out driving, last Friday afternoon, his horse became frightened and started kicking, throwing Mr. Barton out of the carriage, and breaking his left leg just below the knee. The injury is progressing favorably, but it will be several months before he will be able to get down to his office again.

NOT SATISFIED by the large volume of business obtained in the East, the Electric Storage Battery Company, of Philadelphia, has been reaching out for Western trade. So encouraging are the results that the company has deemed it expedient to establish a Western office at 309 Dearborn Street, Chicago, which has been placed in charge of C. W. Woodward, who is well known as a capable man in this line of work. Other branch offices have been established at 15 First Street, San Francisco; 215 N. Calvert Street, Baltimore, and 333 Exchange Building, Boston.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY, of Chicago, reports the following recent contracts for its well-known apparatus: The Ticonderoga Telephone Company, Ticonderoga, N. Y., a complete exchange and toll lines connecting towns along Lake George and Lake Champlain; the Elgin City Railway Company, Elgin, Ill., a complete private telephone system; The Altoona Phœnix Telephone Company, telephone exchange outfit. Other exchanges have been sold at Wapakoneta, Barnesville, Newark, Mount Vernon, and Chillicothe, Ohio, and Lansing, Mich. The exchange at the last-named place will have a capacity of 400 instruments.

THE FIRST CONTRACTS have just been let by the Pabst Heat, Light & Power Company, of Milwaukee, Wis., for a 50,000-light central station. It will be a two-phase alternating-current plant, with motors and lights operating from the same circuits. It is intended to supply the entire city of Milwaukee with both power and lights. The electric contract has been awarded to the Westinghouse Electric Manufacturing Company, and the engines will be of the Willans type. All circuits will be underground, and several new appliances will be used in connection with the wiring. The contracts were let through the office of Chas. G. Armstrong, Chicago, who is retained as consulting electrical engineer by the company.

CANADIAN NOTES.

OTTAWA, ONT., Aug. 16.

INGERSOLL, ONT.—The Town Council are calling for tenders for lighting the town by electricity for a term of five years.

ST. THOMAS, ONT.—Sealed proposals will be received until Aug. 22 for lighting the streets of the city with electricity. A. C. Campbell is city engineer.

RICHMOND HILL, ONT.—A petition is being signed urging the Town Council to grant a bonus of $10,000 toward the extension of the Metropolitan Electric Railway from Toronto to this town.

OTTAWA, ONT.—The Ottawa Improvement Company is having plans made for the construction of a dam at the head of the Chandier Rapids where they expect to realize 10,000 hp to be used for electrical purposes in this city.

OTTAWA, ONT.—Mr. D. H. Keeley has been appointed superintendent of government telegraphs for the Dominion, succeeding the late F. N. Gishorne in that position. He has just returned from the Grosse Isle Quarantine, where he has been laying a new cable between Isle aux Grosse and Reaux and Grosse Isle.

OTTAWA, ONT.—The first truck with electric motors for locomotive works to be used in Canada was shipped from here to Oshawa, Ont., this week by Ahearn & Soper. It is a specially constructed truck of heavy steel and weighs with motors over eight tons. The motors combined have a capacity of 120 hp. The truck will be used in hauling freight cars to and from the Grand Trunk Railway at Oshawa.

General News.

NEW INCORPORATIONS.

THE MUNHALL STREET RAILWAY COMPANY, Pittsburg, Pa., has been formed to construct an electric railway by Albert H. Schultz and John W. Taylor, of Pittsburg, and S. L. Tone, of Rochester, Pa. Capital stock $3,000.

THE WILKINSBURG & RANKIN STREET RAILWAY COMPANY, Pittsburg, Pa., has been formed by Albert L. Schultz, S. L. Tone and John W. Taylor, for the purpose of building an electric street railway. Capital stock $24,000.

THE SEATTLE & RAMER BEACH RAILWAY COMPANY, Seattle, Wash., has been formed to build, equip, operate, buy and sell electric, cable, steam and other railways, boats and other means of transportation. The promoters are Henry Chapin, E. W. Andrews and Josiah Collins, Seattle, Wash. Capital stock $20,000.

THE DANVILLE (ILL) & NORTHWESTERN ELECTRIC RAILWAY COMPANY, capital stock $100,000, has been formed to construct and operate an electric railway. The incorporators are W. T. Cunningham, John W. Dale, William P. Chandler, J. W. Layne, J. K. Butz, W. S. Mathias, W. W. Hatch and Robert Holmes.

THE HOMESTEAD & CALHOUN PARK ELECTRIC RAILWAY COMPANY, Homestead, Pa., capital stock $18,000, has been incorporated for the purpose of constructing and operating an electric railway, by Nathan H. West, Thomas L. Brierly, George Gladden, James B. Neel, Robert M. Elliott, John F. Milliken. Reid Kennedy and Joseph A. West.

THE JENKINTOWN & FOX CHASE ELECTRIC RAILWAY COMPANY, Jenkintown, Pa., capital stock $20,000, has been formed for the purpose of constructing and operating an electric road. The promotors are Howard Fleck, Samuel L. Schively, James Satterthwaite, Thomas B. Harper, Howard Noble, Jenkintown; William P. Longstreth, Fox Chase, Philadelphia.

THE EAST ORANGE ELECTRIC COMPANY, East Orange, N. J., capital stock $150,000, has been incorporated for the purpose of establishing and maintaining electric plants for heat, light and power and telephone service. The promoters are Roderick M. Sanger, Charles C. Jacobus, Alfred Lindsay, Montgomery Lindsay, East Orange, N. J., and William E. Rundle, Newark, N. J.

THE POCATELLO POWER & IRRIGATION COMPANY, Chicago, Ill., has been incorporated with a capital stock of $150,000, to operate water power plants, generate electricity for use in producing light and power and for mechanical purposes; to operate telephones and furnish water for irrigation and domestic purposes. The incorporators are Charles W. Spalding, Daniel Swinehart and Francis W. Smith.

THE LA BURT ELECTRIC RAILWAY COMPANY, New York, N. Y. incorporated in West Virginia, with a minimum capital stock of $500 and a maximum capital of $3,000,000, to conduct, operate and maintain inventions, letters-patent, etc., improvements in the mechanical arts, electrical and other sciences. The incorporators are John La Burt, Brooklyn, N. Y.; Lis Michaelis, Alex. M. Lowery, New York City, and Irving Hull, Bridgeport, Conn.

THE IRON MOUNTAIN RAILWAY COMPANY, San Francisco, Cal., capital stock $100,000, has been incorporated for the purpose of constructing and equipping a railway to be operated by steam or electricity from the Iron Mountain mines to Spring Creek Crossing on the California & Oregon Railway. The incorporators are Louis B. Parrott, Charles P. Ells, M. M. O'Shaughnessy, San Francisco, Cal.; Alfred Fellows, Newcastle-on-Tyne, England, and Charles W. Fielding, London, England.

Electric Light and Power.

CATAWISSA, PA.—The installation of an electric light plant at this place is contemplated at a cost of $8,000.

BUFFALO, N. Y.—The Buffalo & Niagara Falls Electric Light & Power Company's plant is to be improved.

MERIDIAN, MISS.—An electric light plant is to be erected in this city by Messrs. Gilham & Co., of Springfield, Ill.

MARTINS FERRY, O.—Martins Ferry has rejected all bids for the new electric light plant, and will readvertise for 30 days.

SHENANDOAH, PA.—The Shenandoah Heat & Power Company is enlarging its electric light plant at Lloyd and Bowers streets.

ATHENS, GA.—The erection of a municipal electric light plant is contemplated by the City Council. The clerk can give details.

INDIANAPOLIS, IND.—The Board of Public Works has asked the city commissioners for an electric light plant for the court house.

FORREST, ILL.—A franchise has been applied for by C. C. McDonald, of Fairbury, to establish an electric light plant at this place.

CHAMBERSBURG, PA.—The Town Council of Chambersburg has decided to purchase an additional 1,000-light incandescent dynamo.

BRONSON, MICH.—A franchise has been applied for by Bonds & Rhubottom, of Union City, for the establishment of an electric light plant.

IRON RIVER, WIS.—The new electric light company has contracted for all its equipment and expects to have the plant in full operation within sixty days.

ANNAPEE, WIS.—The electric light plant at this place, which was destroyed by fire with a loss of $15,000, will probably be rebuilt. Joseph Wodsedalek is interested.

WALDEN, N. Y.—Arrangements are being made by the electric light company for the enlargement of its plant. The circuits are to be extended to Montgomery.

HAZELTON, PA.—An ordinance has been passed providing for the lighting of the streets by arc lights for a term of five years, by the Edison Electric Illuminating Company of this place.

TOMAHAWK, WIS.—The new dam on the Tomahawk River, together with new electric light plant put in by W. H. Bradley, was entirely washed out by recent freshet. Both will be rebuilt at once.

BLACKWOOD, N. J.—Sealed proposals for an electric light plant at Camden County Asylum and Almshouse will be received until 10 a. m. Sept. 4, by the asylum committee, Samuel Wood, chairman.

SUNBURY, PA.—The Edison Electric Light Company, of Sunbury, has been awarded a contract for lighting East Sunbury borough streets. Seventy-five dollars a year for each arc light is the contract price.

NEVADA, MO.—Col. George Dudley, of St. Louis, has been granted a franchise by the City Council to put in 50 electric lights at $75 per year, with the privilege of putting in an electric street railway line.

TOMS RIVER, N. J.—The engineering firm of Ferris & Richards, backed by a Jersey City syndicate, has made a proposition to the town for the construction of water works and an electric light plant, if the town will grant a franchise.

NEW CASTLE, PA.—The New Castle Arc Light Works, the incandescent plant, and the New Castle Artificial Gas Company have been sold to J. S. Hayes and Robert Peebles, of this city. The price paid by the new owners is not given.

The Electric Railway.

UXBRIDGE, MASS.—There is some talk of connecting Milford with Oxford by an electric road.

FRANKLIN, N. H.—An electric street railway will be built by a company, of which Hon. Warren F. Daniel is president.

ALLENTOWN, PA.—Work will be commenced shortly on the construction of the Allentown & Kutztown Electric Railway.

WEST GENESEE, N. Y.—Work has just been commenced on the construction of the new street railway through this place.

BALTIMORE, MD.—Samuel M. Shoemaker is contemplating the construction of a line from the railway track to Chattalanee Hotel.

CENTRALIA, PA.—A company is being organized for the purpose of constructing an electric railway between this place and Ashland.

CAMDEN, N. J.—The City Council has voted in favor of the ordinance granting the West Jersey Traction Company the right of way in this city.

OLEAN, N. Y.—It is reported that the Fall Brook Railway Company is to extend its line from Mills to this place, via Honeoye Valley, Cortville, etc.

TUSKEGEE, ALA.—An electric road is to be built to Cheraw, a distance of about six miles. The clerk of the Council can probably furnish particulars.

NEVADA, MO.—The Nevada Electric Light Company has purchased a franchise to operate a street railway here, and will add the necessary equipment.

SANTIAGO, CAL.—George B. Kerper, owner of the Santiago Cable Railway, will change the system to electricity and will extend the line to National City.

JERSEY CITY, N. J.—The North Hudson County Railway Company has applied for permission to operate a trolley line through Grove Street to Hoboken.

KILLINGLY, CONN.—The Killingly & Brooklyn Street Railway Company will establish an electric street railway to connect the surrounding villages with Danielson.

NORRISTOWN, PA.—The People's Traction Company has purchased land in Moreland and vicinity for the proposed electric railway between Willow Grove and Moreland.

EWING, N. J.—An ordinance has been introduced to authorize the Trenton Passenger Railway Company to construct, operate and maintain a street railway through this town.

HERKIMER, N. Y.—The Little Falls & Herkimer Railway Company has applied for permission to build its railway over the Mohawk River Bridge, East Ridley, to Little Falls.

PHILADELPHIA, PA.—The Moyamensing Avenue & Penrose Ferry Passenger Railway Company has been granted permission to lay tracks on Otsego and other streets of the city.

STOCKTON, N. J.—An ordinance has been passed by the Town Council granting the West Jersey Railway Company permission to construct trolley lines on certain streets of the town.

PLAINFIELD, N. J.—A new trolley line is projected in Union County. It is to start from Trimbley and will connect at Cranford, with the trunk line of trolleys for Elizabeth and this place.

PORTLAND, ME.—It is reported that Yarmouth, Cape Elizabeth and Gorham are to be connected with this city by an electric railway. Charles K. Robinson is interested and can furnish particulars.

BLOOMSBURG, PA.—A plan is on foot to connect Danville and Bloomsburg with an electric railway. The company is made up of Danville men, and is said to be backed by Allentown capitalists.

Personal Note.

DR. ALEXANDER MACFARLANE, formerly professor of the University of Texas, has accepted the chair of lecturer in electrical engineering at Lehigh University. Dr. MacFarlane's reputation as an investigator in mathematical physics is an international one and his work has caused his election to honorary membership in several European societies.

Miscellaneous Notes.

MR. A. LANGSTAFF JOHNSTON, who has had charge of the electrical equipment of the Hestonville, Mantua & Fairmount Passenger Railway Company, of Philadelphia, has completed his work with that company and resigned his position as engineer.

MR. WILLIAM C. BENBOW, who has for the past six or seven years been identified with the engineering and mining departments of the Thomson-Houston and General Electric companies, has recently resigned this position to assume the management of the mines of the Cambridge & Guernsey Consolidated Fuel Company, at Cambridge, O.

TELEGRAPHERS' REUNION.—The United States Military Telegraphers' Corps and Old Time Telegraphers' Historical Association will celebrate their 15th annual reunion in New York on Sept. 11, 12 and 13 next. The convention will open with a business meeting at 10 o'clock a. m., Sept. 11, to follow which various modes of entertainment have been planned, among other enjoyable features being a trip to Long Branch on the second day of the meeting. The headquarters will be at the Broadway Central Hotel, 667 Broadway.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION will hold its second annual meeting in connection with the American Association for the Advancement of Science, at Springfield, Mass., Sept. 2, 3 and 4. The programme includes no less than seventeen papers, among the titles of which we note "Electrical Engineering," by Prof. D. C. Jackson, "Teaching Industrial Application of Electricity," by D. G. Shepardson, and several others having a bearing on electrical engineering education. Among the other papers are criticisms by six eminent foreign professors on American engineering schools.

Trade and Industrial Notes.

CHANGE IN FIRM.—Walter H. Morton, formerly in charge of the testing department of the General Electric Company, has been admitted to partnership in the firm of Nightingale & Johnson, of Utica, N. Y. The firm name has been consequently changed to Nightingale, Johnson & Co.

AN IDEAL ENGINE ROOM in both senses is that at Keith's Theatre, New York, where three 175-hp Ideal engines are driving, by direct-connection, three 100-kw incandescent dynamos with almost absolutely no noise. The engine room is finished in white marble and there is not a speck of grease, oil or dirt to be found anywhere.

AN ATTRACTIVE PAMPHLET, setting forth the advantages embodied in the company's methods, is being distributed by the Electrical Maintenance Company, 50 Broadway, New York. The company, for a fixed sum per annum, holds itself liable to replace, to repair any damage which may befall electrical apparatus regardless of the extent of the injury.

THE COTTON STATES AND INTERNATIONAL EXPOSITION, Atlanta, Ga., has awarded the contract for high-grade arc-light carbons to Mr. Hugo Reisinger, of 38 Beaver Street, New York, who is sole United States agent for "Electra" Nuernberg carbons. The award was made after an exhaustive test of a number of other imported goods.

A FLOURISHING BUSINESS is reported by the Delaware Hard Fibre Company, of Wilmington, Del., necessitating the operation of the works day and night, notwithstanding the fact that the size of the plant has been doubled. The company has secured the contract for furnishing the General Electric Company with fibre, and this work alone is sufficient to give employment to quite a large number of hands.

THE FUEL ECONOMIZER COMPANY, of Matteawan, N. Y., reports that business is improving and the factory is now very busy, among some of the large orders recently closed being the following: Anaconda Mining Company, Anaconda, Mont., 2,400 hp; Edison Electric Illuminating Company, Paterson, N. J., 2,000 hp; Albany Electric Illuminating Company, Albany, N. Y., 600 hp; Toledo Traction Company, Toledo, Ohio, 2,000 hp; West End Street Railway Company, Boston, Mass., 2,000 hp.

BRANCH OFFICES have been established by H. E. Collins & Co., of Pittsburg, Pa., sole sales agents for the Cahall vertical water-tube boiler, at No. 24 South Water Street, Cincinnati, Ohio, in charge of Mr. John R. Bitner; at No. 71 Perin Building, Cleveland, Ohio, in charge of Alex. H. Lewis, and at No. 712 Union Street, New Orleans, La., in charge of Lewis Metesser. The representatives chosen have all been long connected with the boiler business in different fields and are all capable, earnest and energetic men, and give great promise of extending the sales of the Cahall boilers even beyond the original expectations of either the manufacturers or the original promoters.

A NOVEL MAIL BOX is being put on the market by the Metropolitan Electric Company, of Chicago. The device is known as the Coe electric alarm mail box, and the construction is such that the act of inserting the letter rings the house bell a predetermined length and number of times, thus distinguishing the postman from a caller. It requires no extra wiring, battery or bell, and is claimed to be simple and entirely reliable. The Metropolitan Company has also secured the Western agency for the Ship cored carbons, manufactured in Vienna, Austria. These goods have already established an excellent record and as the company has placed a large stock order, the imported carbons can be furnished promptly from the Chicago house.

SNOW PLOWS are not required extensively just at this season of the year, but later on, before the problem of keeping street railway tracks open assumes formidable proportions, it might be of interest to glance through the catalogue of Wendell & McDuffie, 26 Cortlandt Street, New York, sales agents for the snow plows of the Taunton Locomotive Manufacturing Works. The catalogue contains descriptions and excellent illustrations of both heavy and medium weight plows for single and double-track service, one of the salient features of all of which is an arrangement enabling the motorman to drop the "diggers" into place by a kick of the foot, or lift them by a single movement of a quick-acting lever. These plows were put on the market last fall, and it is stated that twelve of them were sold before any had been practically tested, so obvious was the mechanical excellence of the apparatus.

PHENOMENAL in operation is what Braucher Brothers, Danville, Ill., claim for their Little Giant feed-water heater, which they describe at length in a very neatly executed pamphlet. Some of the advantages to which the catalogue calls the reader's attention are absence of tubes to become clogged and leak, direct application of the heat without the intervention of a radiating surface between the steam and water, and unusually small floor and head space occupied. The Little Giant heater is designed to be placed directly upon the boiler shell, dispensing with connecting pipes entirely. It consists of a heating and purifying chamber attached to the boiler shell, immediately above which is a settling basin, and above this a series of distributing pans. A remarkable feature of the apparatus consists in the employment of a single opening between the heater and the boiler, through which the steam passes outward to the heater and the water inward to the boiler. To fully appreciate the construction and disposition of the various parts it is necessary to have a copy of the catalogue, which is furnished upon application.

Business Notices.

ELECTRIC LEAGUE.—Meets every Thursday evening, 100 West 24th Street, New York. Electrical engineers and electricians cordially invited.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 15 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED AUGUST 13, 1895.

(In charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

544,278. ELECTRIC RHEOSTAT; F. B. Badt, Chicago, Ill. App. filed May 31, 1895. The combination of a glass plate having the conductors imbedded therein and in connection with the terminals of the rheostat, and metallic plates clamped to the said glass plate for support.

544,283. CONDUIT FOR ELECTRICAL CONDUCTORS FOR RAILWAYS; F. L. Cappa, Newark, N. J. App. filed Sept. 18, 1894. The combination of pairs of separable arms having extensions carrying terminals adapted to make electrical contact, and a compressible protector covering the terminals.

544,289. SYSTEM OF ELECTRICAL DISTRIBUTION; S. C. C. Currie, New York, N. Y. App. filed Nov. 27, 1893. A method of maintaining a constant load on a prime motor which consists in driving two mechanically connected dynamos by the prime motor, supplying the main circuit with one, and charging the secondary circuit with the other, varying the field magnetism of the second by the current of the first, whereby the E. M. F. of the second will be varied inversely as the load on the first, and the second machine driven as a motor by the battery when the load on the line is excessive.

544,306. CONDUCTOR FOR ELECTRIC RAILWAYS; P. C. Just, Chicago, Ill. App. filed Feb. 6, 1893. The combination with two contiguous ends of two conductor sections, a clamp connecting them by adjustable securing means, whereby the clamp may be loosened to permit sliding of the other conductor-end within the clamp, or may be made to clamp the conductor-end more tightly as desired.

544,312. TROLLEY FOR UNDERGROUND RAILWAYS; M. D. Law, Washington, D. C. App. filed Jan. 31, 1894. A slotted conduit in which the line conductors are located, a supporting bar extending from the car, a trolley-carrying arms mounted thereon, but insulated from the bar conductors from the motor of the car to the said arms with fuses interposed between the said insulated connecting wire and the arms.

544,313. TRAVELING CONTACT DEVICE FOR ELECTRIC RAILWAYS; J. C. Love, Philadelphia, Pa. App. filed Sept. 5, 1893. A contact device composed of a supporting bar, a trolley wheel mounted on an arm to oscillate, a restraining member connected with the outer section of the said arm, whereby the trolley tends to remain in its central position and plane of oscillation.

544,318. MULTIPLE FUSE SWITCH; J. Melzer, Saaz, Austria-Hungary. App. filed Oct. 20, 1893. A switch consisting of revoluble drum, having insulating heads thereon, removable fuse carriers supported by such heads, and suitable contacts for one or more such carriers and means for preventing the turning of the drum in one direction.

544,322. TRACKER FOR MECHANICAL MUSICAL INSTRUMENTS; H. C. Reichardt, Pottsville, Pa. App. filed Dec. 18, 1894. A tracker consisting of a number of metallic pins passing through the same, metallic fingers each forming contact with one end of each tracker pin, a perforated music sheet passing across the tracker, and electric connections between the tracker pins and fingers for actuating the operating parts.

544,329. COMMUTATOR CONNECTION FOR DYNAMO-ELECTRIC MACHINES; H. H. Wait, Chicago, Ill. App. filed March 1, 1895. The combination of a connection box, conductors connecting the armature coils with the commutator segments located in the said box, the box being detachably connected to the armature coils.

544,332. ELECTRO-MAGNETIC DAMPER FOR MEASURING INSTRUMENTS; E. P. Warner, Chicago, Ill. App. filed Sept. 18, 1894. The combination of a coil or helix through the current to be measured is to be passed, an armature mounted within the said coil and adapted to rotate about an axle parallel with the axis of the coil, an index finger adapted to cover a scale and a metallic disc mounted to rotate with the armature, the disc rotating to act as a damper.

544,335. TELEPHONE SWITCH; F. R. Whitney, Lewiston, Me. App. filed June 30, 1894. The combination of a pair of contacts in the same horizontal plane, a switch-lever turning upon a pivot and shifting from one to the other of the contacts, and a spring holder for a receiver rigidly attached to the switch arm.

544,341. MULTIPLE SWITCHBOARD SYSTEM; O. A. Bell, Brooklyn, N. Y. App. filed Feb. 21, 1893. The combination of a telephone line connected with spring jacks upon different switchboards and terminating in a connecting plug at one of the boards; a test circuit independent of the line extending to the different spring jacks, a cord switch for the terminal plug adapted to alter the connection of the test circuit with a source of electrical condition of the test contacts when the plug is removed from its socket.

544,345. App. filed April 16, 1894; 544,346. App. filed Jan. 10, 1895; 544,347. App. filed Jan. 10, 1895; 544,348. App. filed May 20, 1895; C. L. Buckingham and E. Germann, New York, N. Y. PRINTING TELEGRAPH. The combination of a series of selecting relays and adjuster magnets controlled thereby, a restoring circuit and a controlling relay for the latter in one of the distributer branches.

544,351. RELAY; T. B. Dixon, Henderson, Ky. App. filed Nov. 17, 1892. The combination of an electromagnet having a pivoted armature, a retractile spring attached to the armature and means for limiting the movement of the armature.

544,358. COMMUTATOR BRUSH HOLDER; G. J. Junker, Mount Vernon, Ill. App. filed Nov. 9, 1894. A brush holder formed of a sleeve, a series of brush holders mounted on another insulated sleeve and a rod extending through the brush holders but insulated therefrom.

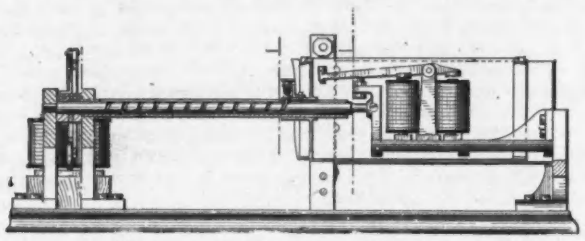
544,361. CONSTRUCTION AND METHOD OF OPERATING DYNAMO-ELECTRIC MACHINES; F. H. Loveridge, Coldwater, Mich. App. filed Aug. 2, 1894. A machine having two or more sets of pole-pieces, pairs of brushes and independent circuits equal in number to the sets of pole-pieces, separate brushes forming pairs of brushes constituting the terminals of the different circuits, being placed under pole-pieces of different signs, and one brush of each pair being adapted to be adjusted, all adjusted

brushes being of the same sign, whereby the different currents may be regulated and maintained each at the desired value.

544,363. THERMOSTATIC INSTRUMENT; M. Martin, Malden, Mass. App. filed June 5, 1893. An instrument composed of a protecting hood enclosing it and having a movable member independent of the instrument and capable of movement without operating the said instrument, and a fusible material governing the action of the movable member of the hood.

544,365. SYNCHRONISM INDICATOR; R. D. Mershon, Pittsburg, Pa. App. filed Nov. 12, 1894. The combination of two alternating-current electric machines, a coil in series with said machines and a pivoted armature in inductive relation to said coil, the position of said armature serving to indicate the relation of said machines.

544,368. App. filed May 31, 1894; 544,369. App. filed Sept. 18, 1894; 544,370. App. filed Dec. 26, 1894. TELEPHONE SYSTEM; F. R. McBerty, Powner's Grove, Ill. The combination of a connecting plug of a telephone switchboard, a source of electric current, contacts adapted to connect the source of current with terminal piece of the plug and disconnect it therefrom, mechanism adapted to separate said switch contacts, an electromagnet for controlling the mechanism, and means for exciting the electromagnet to operate the mechanism in the act of establishing connection with the line.



No. 544,345.—Printing Telegraph.

544,372. MANUFACTURE OF ELECTRIC CABLES; W. R. Patterson, Chicago, Ill. App. filed Aug. 24, 1891. A method of insulating cables consisting in tightly winding spirally upon the individual wires parer tape, and then bunching the wires together, and then twisting the said wires in mass in a direction opposite to that of the winding of the tape to partially untwist and thereby loosen the individual windings in the act of forming the strands of the cable.

544,383. App. filed Dec. 6, 1887; 544,384. App. filed Dec. 1. 1890; 544,385. App. filed July 7, 1891; 544,386. App. filed Dec. 26, 1894; 544,387. App. filed Jan. 8, 1895; 544,388. App. filed May 13, 1892. TELEPHONE SYSTEM; E. Scribner, Chicago, Ill. A system having line circuits extending from each of several substances to an exchange, a spring jack for each line provided upon each of the boards, a calling circuit extending to each of the substations, an electromagnet receiving device at each of said boards, said receiving devices being included in said calling circuit and adapted to simultaneously respond to calling currents sent from any station.

544,391. ELECTRIC RAILWAY CONDUIT SYSTEM; L. H. Sherwood, Mount Vernon, N. Y. App. filed Sept. 7, 1894. The combination of a conduit, a main conductor, a tubular secondary conduit supporting the main conduit entirely out of contact with the said main conduit, and provided at one side with a slot and with a wire tube, the service wire being supported within and above the bottom of the secondary conduit, the main conductor being supported within the main conduit, and a curved trolley arm within the secondary conduit and adapted to make contact with the conductor therein, and also with the main conductor outside.

544,396. WINDING OF DYNAMO-ELECTRIC MACHINES OR MOTORS; E. Thomson, Swampscott, Mass. App. filed Jan. 27, 1894. A dynamo machine having projections, a number of conductors wound between successive projections, the E. M. F. of which would not necessarily be in phase, but the current in which is one of phase and is the resultant of the current producing tendencies in each of the divisions.

544,419. ELECTRIC WIRE CONTAINING HAT OR CAP BAND; A. M. Rodriguez and E. D. Rockwell, Brooklyn, N. Y. App. filed June 10, 1895. An electric wire containing hat or cap band, provided with terminals for the application and removal of an electric lamp and the application and removal of wires bringing an electric current to the said band, and hence the lamp.

544,430. SUPPORT FOR ELECTRICAL BATTERIES USED ON VEHICLES. T. Froggatt, London, Eng. App. filed May 1, 1895. A support having a connecting piece elastically upon and insulated from the part upon which it is mounted in combination with another connecting piece adapted to make electrical connection with the elastically mounted connecting piece so as to absorb vibration and prevent its transmission from one to the other.

544,436. AUTOMATIC SAFETY APPLIANCE FOR ELECTRICAL CONDUCTORS; A. E. Hutchins, Detroit, Mich. App. filed May 9, 1893. The combination of a main wire with forked arms, one of which is provided with a spring-actuated latch pivoted thereon, said latch being arranged to be displaced by the main conductor as it falls and to return to its original position.

544,501. CLEAT FOR HOLDING ELECTRIC WIRES; E. W. Buffinton, Fall River, Mass. App. filed March 15, 1895. A cleat consisting of a base and a cap made exactly alike, each part having its face at one end formed into longitudinal serrated surfaces, and into transverse grooves at the other end.

544,502. SUPPORT FOR INCANDESCENT LIGHTS; C. A. Carmany, Middletown, Pa. App. filed Sept. 8, 1894. A support consisting of a block or base carrying a shaft, supports and a collar loosely mounted upon the shaft, a disc loosely mounted on the collar, an internal toothed wheel secured to one of the supports, a drum rotatably mounted upon the shaft, and a spring operating upon the parts.

544,514. ELECTRIC GAS LIGHTER; E. Orling, Stockholm, Sweden. App. filed Feb. 5, 1895. The combination of a gas burner having a mixing chamber with inlets for gas and air thereto, an auxiliary gas jet tube connected at its receiving end with the gas inlet pipe of the burner, whereby it receives pure gas unmixed with air, and an automatic electric spark-producing device.

544,529. ELECTRIC ARC LAMP; R. H. Cunningham, Richmond, Va. App. filed Sept. 8, 1894. An arc lamp comprising a main solenoid and a positive carbon holder, the core of the solenoid being attached to the holder, a negative carbon holder, the core of the solenoid being positively attached to the holder, and a winding drum having two different-sized spools over which two cords pass, one cord being connected with the core of one solenoid, while the other is connected with the core of the other solenoid, the cores of both solenoids being acted upon constantly by a force such as gravity and the arrangement being such that the forces thus acting balance each other.

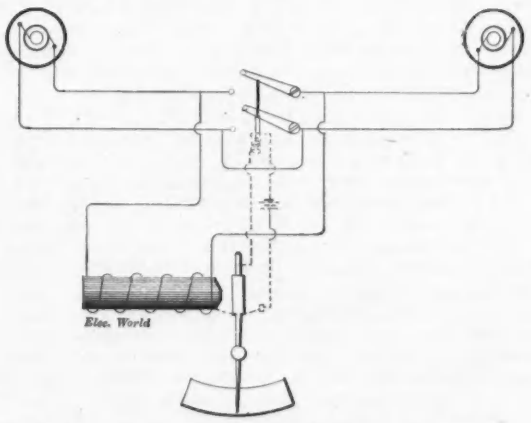
544,530. App. filed Nov. 14, 1891; 544,531. App. filed Feb. 18, 1893; INSULATED ELECTRIC CONDUCTOR; T. N. Hallanger, Chicago, Ill. A cable consisting of conductors twisted or bunched together, each being surrounded by a tube of insulating material having an inside diameter considerably greater than the diameter of the conductor to thereby leave an air space about the conductor.

544,545. SIGNAL APPARATUS FOR TELEPHONE EXCHANGES; J. J. O'Connell. App. filed April 17, 1893. 544,546. Filed April 17, 1893. A telephone system having a trunk line connecting two offices, a spring jack wherein the trunk line terminates at one of said offices, a supplemental signal wire extending between the offices connected, but normally broken at such point with the spring jack, a battery to supply current to the signal wire, an operator's key at one office to which signal wires lead, whereby the passage of current over the signal wire is not effected until the trunk line terminal at one office is inserted in said spring jack, and the operator's key at the other office is shifted.

544,552. ELECTROTHERAPEUTIC APPLIANCE; J. E. Wiles, Milwaukee, Wis. App. filed Jan. 14, 1895. An appliance comprising a handle in the form of a tube, a series of galvanic cells located therein, contact discs secured to the opposite ends of the handle, having connections with opposite terminals of the series of cells, and a connecting device for connecting either terminal with the handle.

544,567. ELECTRICAL SIGNALING APPARATUS; W. W. Dean, St. Louis, Mo. App. filed Sept. 24, 1894. A signaling apparatus consisting of a plate having two perforations therein, two signaling plates arranged adjacent to the perforations, electromagnets for operating the signal plates having their armatures connected directly to the respective signaling plates, and an interlocking extension from the armature of one of said magnets and adapted to be placed within the path of travel of the armature of the other magnet.

544,578. ELECTRIC ARC LAMP; J. H. J. Haines and A. B. Fernald, New York, N. Y., and 544,579, filed the same date, Nov. 20, 1894. The combination of a carbon carrier in the form of a reciprocating non-rotating screw, having a nut free to rotate on the screw; a movable support on which the nut rests, and a detent carried by said support and engaging said nut to hold it from rotation, and adapted to release it when a feed of the carbon is required.



No. 544,365.—Synchronism Indicator.

544,633. COMBINATION DYNAMO; E. P. Warner, Chicago, Ill. App. filed Feb. 24, 1890. The combination of field magnet coils included in series with the working circuit, a switch adapted to short circuit a portion of the field magnet coils to reduce the field strength, and brushes adapted to be moved about the commutator to a position of no spark under the new field strength, whereby the dynamo may be readily converted from a full to a half arc machine.

544,634. ELECTRIC LIGHTING ATTACHMENT FOR GAS BURNERS; F. A. Webb, Beverly, Mass. App. filed March 11, 1895. The combination of a gas burner having a mixing chamber wherein gas and air are mixed, a stationary insulated electrode and a movable yielding electrode both arranged within said mixing chamber.

544,644. FOUNTAIN INK ROLLER FOR TELEGRAPH REGISTERS; C. A. Rolpe, Chicago, Ill. App. filed Oct. 13, 1894. The combination of a hollow wheel provided around its periphery with openings, a layer of padding or absorbent material surrounding the periphery of said wheel, and a gravity valve within said hollow wheel for sealing the openings lowermost in any position of the wheel to prevent the passage of the ink therethrough.